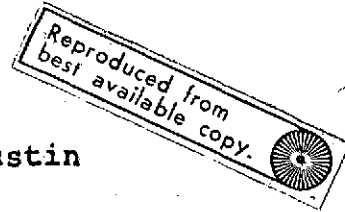


Final Technical Report on Grant NGR 44-012-279
"Mariner 9 High-Resolution Albedo Mapping of Mars"
for the period July 1, 1973 - June 30, 1974

G. de Vaucouleurs
Department of Astronomy

The University of Texas at Austin
Austin, Texas 78712



1. Personnel - Dr. G. de Vaucouleurs, Principal Investigator, supervised all major aspects of the mapping program, attended the IAU meeting in Sydney, Australia, reported on Martian Nomenclature, and analyzed distribution of spot counts. He maintained close communications with USGS, Flagstaff, concerning mapping and nomenclature problems.

J. Roth, Cartographer, was in charge of routine operations, printing and mailing of maps, supervision of assistant cartographer, made studies and did airbrush work on specific charts. Mrs. K. Walker, Assistant Cartographer, made studies and did airbrush work on specific charts. Mrs. Walker, Mrs. Mulholland and Mr. Roth shared the additional project work assignments of research, drafting and inking of crater nomenclature maps and spot count printing layouts, map mailing, list compilations; consultation, expediting, liaison; reviews of airbrush mechanical performance, and general administrative assistance.

Mrs. E. Lister was employed as Senior Secretary on a part-time basis from January to June 1974.

Mr. H. Corwin, worked for one month to complete statistical analysis of his counts of small scale albedo markings on the

(NASA-CR-138696) MARINER 9
HIGH-RESOLUTION ALBEDO MAPPING OF MARS
Final Technical Report, 1 Jul. 1973 - 30
Jun. 1974 (Texas Univ.) 41 p HC \$5.25

N74-27347

Unclass

CSCS 03B G3/30 41901

Mariner A frames, and to prepare contour maps of their planet-wide distribution (fractional area coverage and average size). Airbrush color charts illustrating the results were prepared by J. Roth.

2. Progress during report period - The first six months (July 1 - December 31, 1973) was a transition period from terminal funding by the Mariner 9 project and initial funding by NASA headquarters. Previously prepared maps were printed (under JPL funding) and a limited distribution made (as directed by project). The University of Texas Mars Group supervised, expedited and evaluated the offset lithography of 5 albedo maps (10 versions with grid and sans grid). MC 8 (Amazonis), MC 9 (Tharsis), MC 17 (Phoenicis Lacus), and MC 18 (Coprates) were printed at scales of 1:5,000,000. A chart of mars (based upon 1971 observations with the 155-cm Catalina reflector of the Lunar and Planetary Laboratory, The University of Arizona, Tucson, Arizona) was printed at a scale of 1:25,000,000. Image quality desired on the albedo maps required close, time-consuming supervision and analysis during the summer of 1973. A report on the Texas Mariner 9 and ground-based albedo maps of Mars appeared in Sky and Telescope, September, 1973.

Work on new 1:5,000,000 scale albedo quadrangles was started July-December, 1973 and continued during the second six months of January-June, 1974: MC 10 (Lunae Palus) was begun and finished by Kay Walker; MC 11 (Oxia Palus) was begun by Claire Mulholland and finished by James Roth following Mrs. Mulholland's departure

for France with her family for an extended stay. MC 15 (Elysium) was begun by Mr. Roth and completed by Mrs. Walker. MC 13 (Syrtis Major) was begun early in the year by Mr. Roth. MC 13 now is very close to completion. Mrs. Walker is presently working on MC 12 (Arabia). Positional studies were started on MC 14 (Amenthes) and subsequently suspended, awaiting prior commitments to finish other quads. With the exception of MC 14, our group has now nearly complete map coverage of the Martian surface within the northern equatorial latitudes 0° to $+30^{\circ}$. (See attached chart). We expect to make good progress on the southern belt in the coming year.

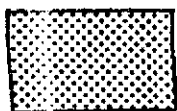
Changes in the huge Solis Lacus region (and surrounding areas) of Mars make it appear different in 1973 than it did in 1971. Dr. de Vaucouleurs has examined historical accounts of changes in Solis Lacus in some detail. He finds that its appearance in 1973 is almost identical with the way it looked in the year 1877, as observed by the French, Italians, and English. Dr. de Vaucouleurs has prepared for publication in Sky and Telescope a short report on this major change. Photomontages and supporting text were sent to a number of planetary research centers. (Appendix A, B)

3. Publications

"Preliminary Albedo Map of the South Polar Region of Mars" (with J. Roth and C. Mulholland), Journal of Geophysical Research, vol. 78, No. 20, July 10, 1973, pp. 4436-4439.

"High-resolution Mars Albedo Maps", Sky and Telescope, 46, No. 3, September 1973, pp. 140-143.

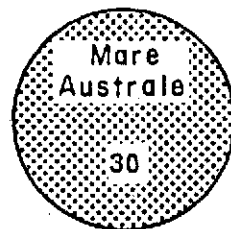
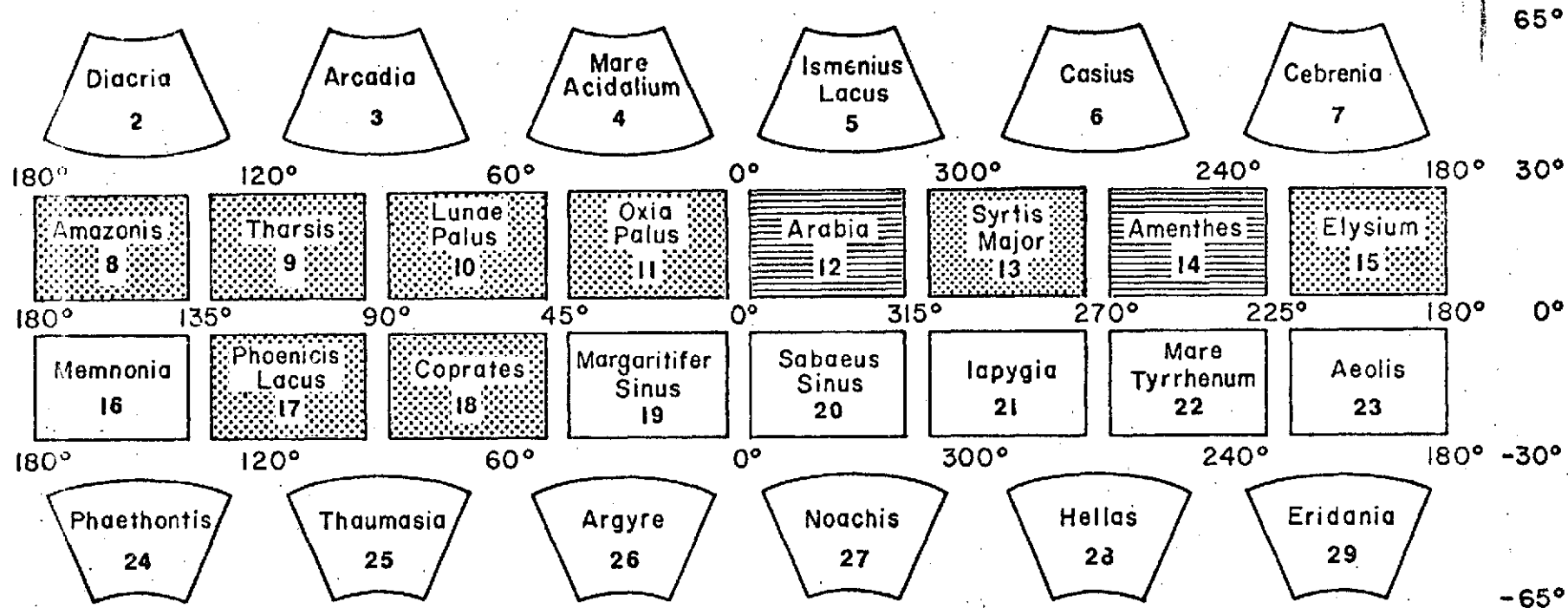
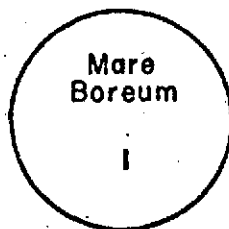
"New Changes in the Solis Lacus Region of Mars," Sky and Telescope, August 1974, in press.

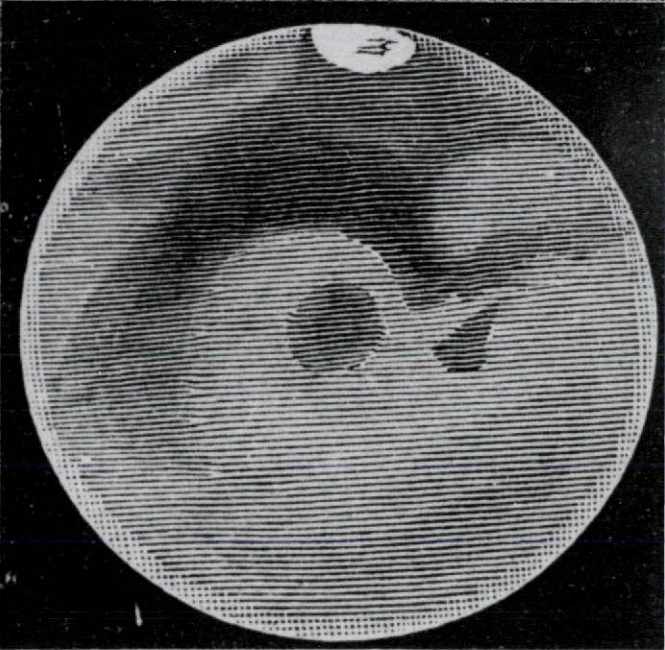
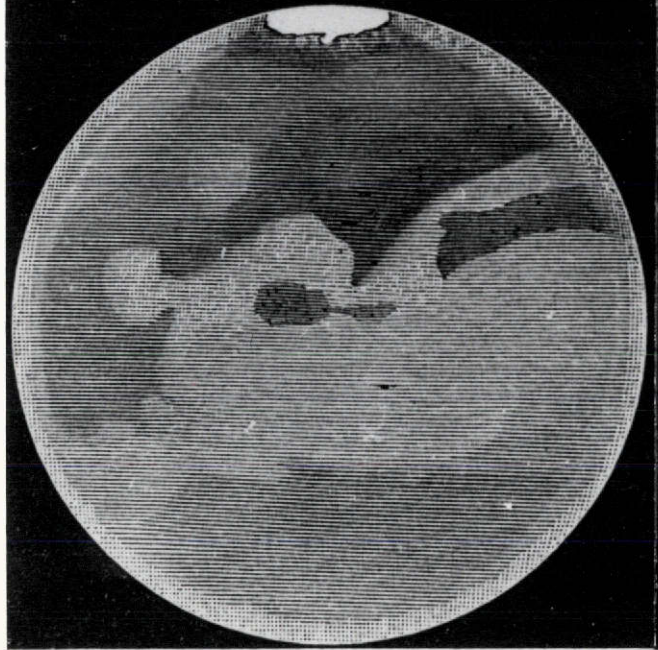
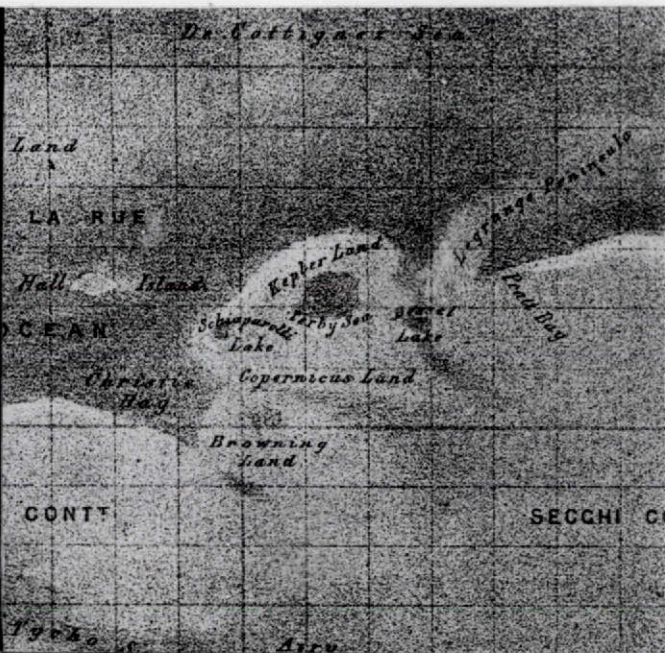


Mars Chart quadrangles
completed by University
of Texas to date



In progress (6-30-74)





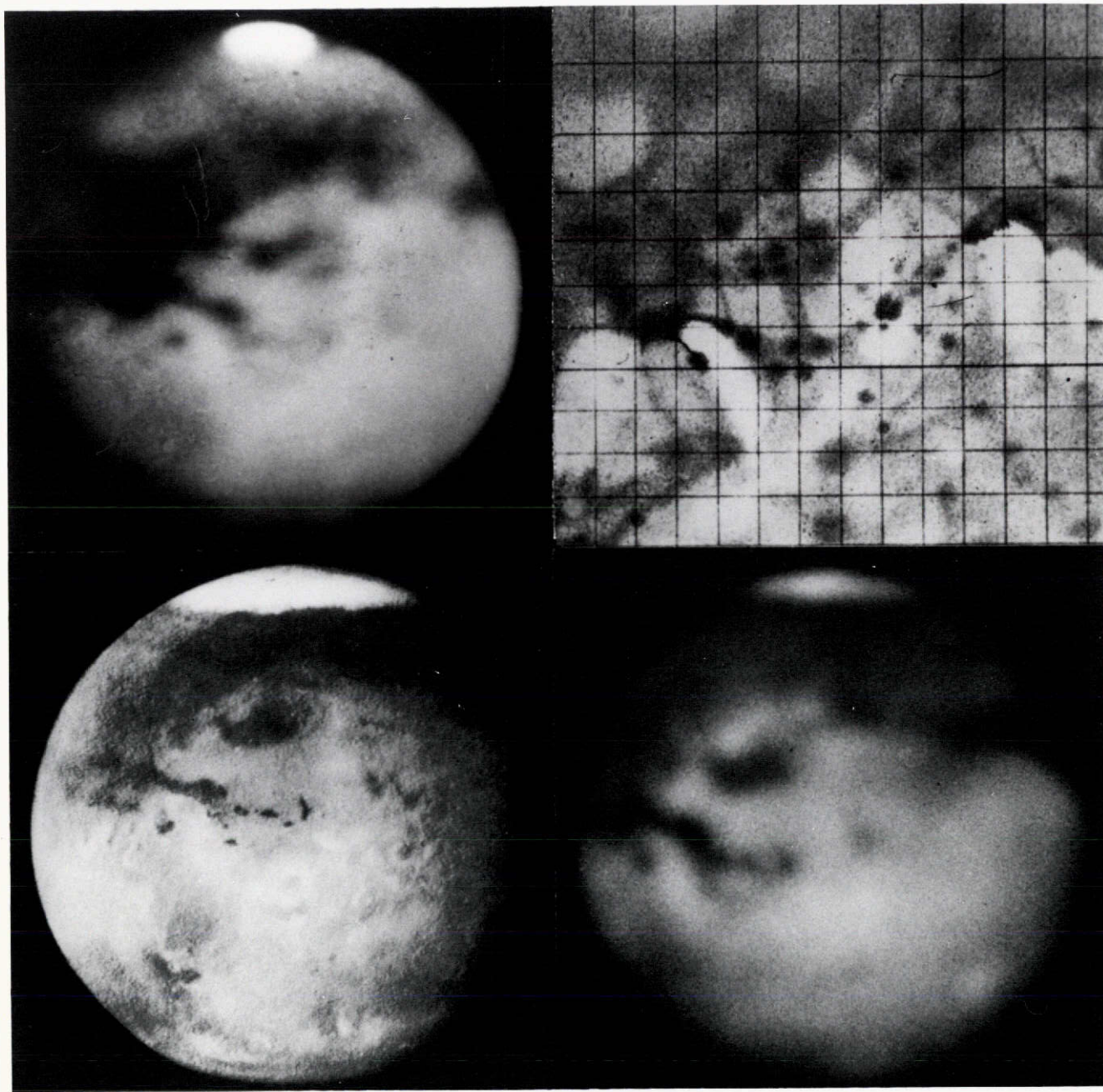
M A R S N E W S

(Plus ça change, plus c'est la même chose)

THE LATEST CHANGES OF SOLIS LACUS AREA IN 1973 RETURN IT TO ITS UNUSUAL ASPECT OF 1877

1. Upper left: Mars on October 9, 1973 showing "new" distorted shape of Solis Lacus near center and unusual darkening of Daedalia West (right) of it. Composite from International Planetary Patrol Photographs; courtesy Planetary Research Center, Lowell Observatory.
2. Upper right: Part of Mars map by English painter, Nathaniel Green, from observations made in August, September and October, 1877 with 13-inch Newtonian reflector on the island of Madeira. (Memoirs of the R. Astron. Society, vol. XLIX, p. 123)
3. Lower left: Drawing of Mars on September 29, 1877 at 2100 G.M.T. by N. Green showing abnormal shape of Solis Lacus near center of disk and unusual northward extension of Aonius Sinus forming dark wedge along Phasis on Daedalia.
4. Lower right: Drawing of Mars by Paul and Prosper Henry on August 27, 1877 with 24-cm refractor of Paris Observatory showing similar aspects of Solis Lacus and Aonius Sinus. (C. Flammarion, La Planète Mars, vol. I. p. 255, Paris 1892).

Compare with more "normal" aspects of same region in recent years shown on panel at right.



SOME CLASSICAL ASPECTS OF SOLIS LACUS AREA

BETWEEN 1909 AND 1971

1. Upper left: Mars on September 20, 1941 shows Solis Lacus near center with usual multi-nucleated structure (note strength of East component), normal aspect of bright Daedalia desert West of it and dark Sirenum Sinus at sunrise limb (right). Composite from yellow light photographs with 24-inch refractor of Pic du Midi Observatory, France; courtesy Planetary Research Center, Meudon Observatory.
2. Upper right: Part of composite Mars map by French observer, E.M. Antoniadi, based mainly on his observations with the 32-inch refractor of Meudon Observatory from 1909 to 1924. Note patchy structure of dark areas. (*L'Astronomie*, 1926, p. 352).
3. Lower left: Mars on August 4, 1969 televised by the 8-inch Vidicon B camera of the Mariner 7 spacecraft at a range of 514,810 km shows slightly better resolution than ground-based telescopic observations; courtesy Jet Propulsion Laboratory, Pasadena, California.
4. Lower right: Mars on August 16, 1971 shows incipient Eastward spreading of dark material from Sirenum Sinus over Daedalia (at right), but Solis Lacus still with fairly normal appearance as in 1969 (note strength of West component and lack of internal detail as in 1969). Composite of red light photographs with the 61-inch reflector of Catalina Station; courtesy Lunar and planetary Laboratory, University of Arizona.

Compare with unusual appearance of same regions in 1877 and 1973 shown on panel at left. South at top, areographic East at left.

MARINER 9 ALBEDO MAP OF MARS

CHART MC 8

AMAZONIS

6
A

This map was made from both unrectified and rectified Mariner 9 photographs for small-scale features combined with ground-based telescopic observations for large-scale albedo markings. The latter were observed near the opposition of 1971 with the 155-cm reflector of the Catalina Station of the Lunar and Planetary Laboratory, University of Arizona (Sky and Telescope, 42, 1971, 134, 260, 263; 43, 1972, 20).

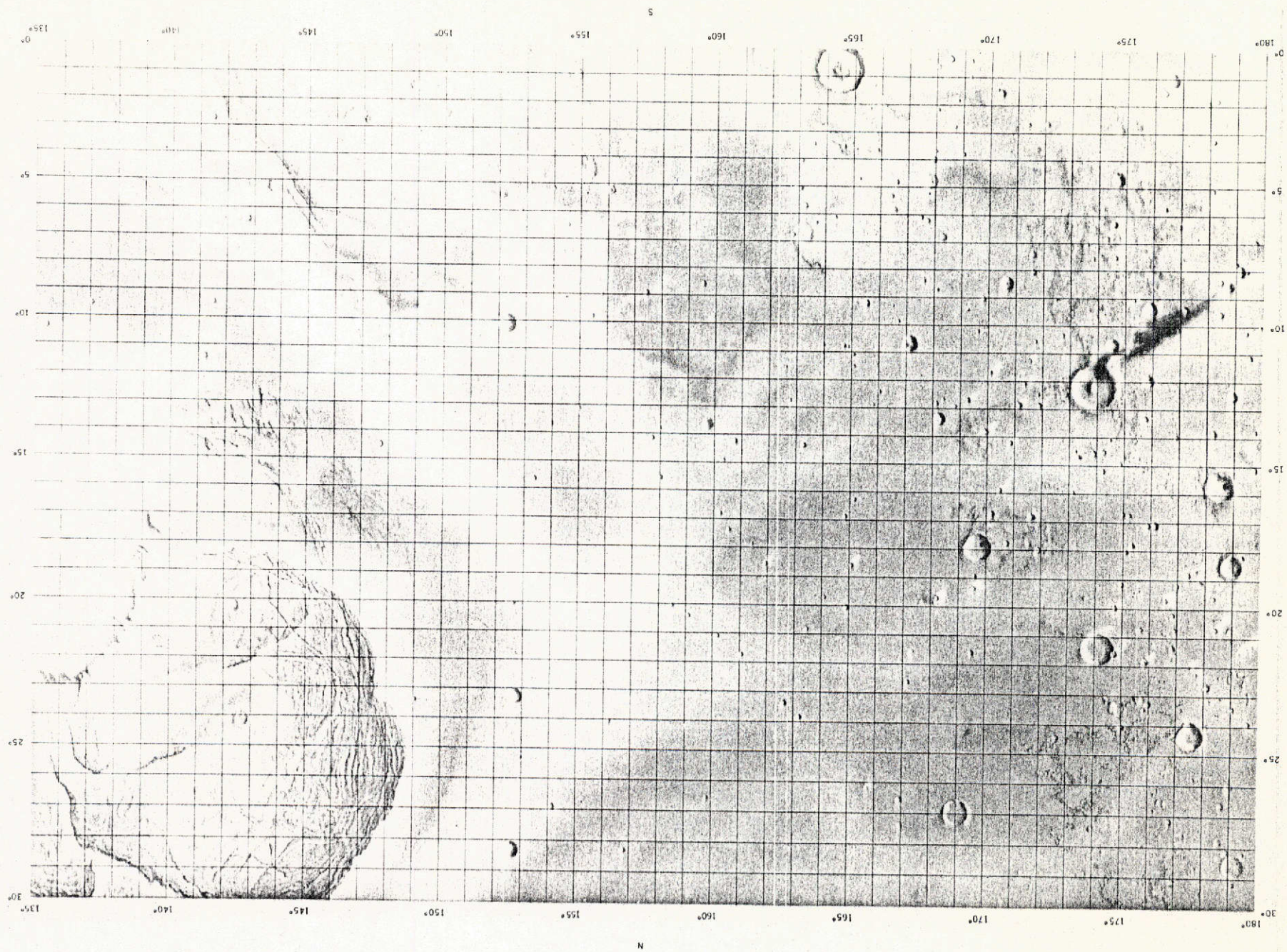
The grid conforms to the Mariner 9 areographic coordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, July 10, 1973) and the individual features were approximately adjusted to that system by visual interpolation between the primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1122-JPL, October 1972).

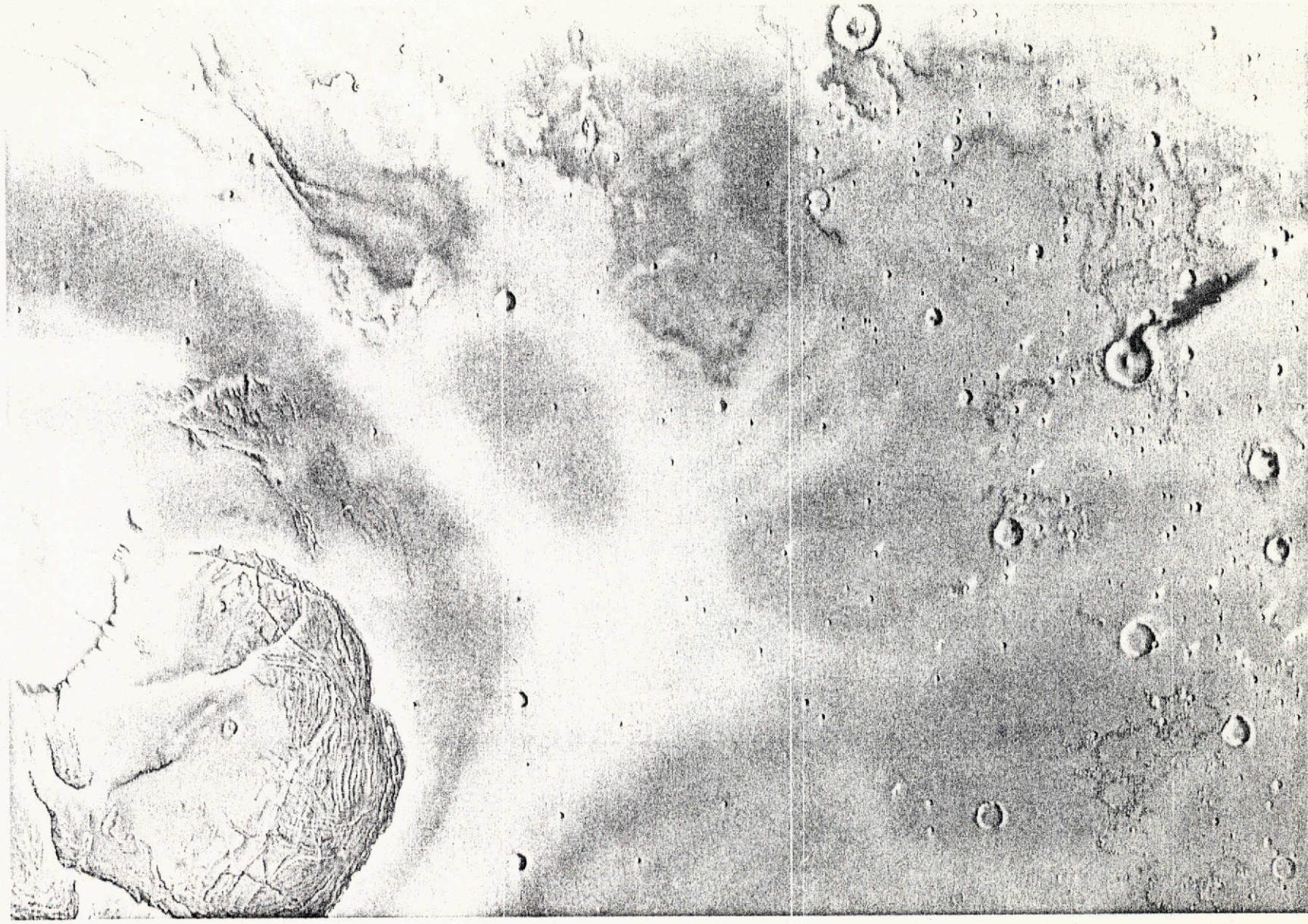
The relief is shown with reduced contrast to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the map, regardless of the actual illumination of the Mariner 9 pictures.

MERCATOR PROJECTION
Scale of the original art work is
1:5,000,000 at the equator

This chart was prepared by C. Mulholland in the direction of Dr. G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

This document was produced for the Mariner Mars 1971 project under contract 952490 with the Jet Propulsion Laboratory, Pasadena, California.





MARINER 9 ALBEDO MAP OF MARS

CHART MC 9

THARSIS

12<

This map was made from both unrectified and rectified Mariner 9 photographs for small-scale features combined with ground-based telescopic observations for large-scale albedo markings. The latter were observed near the opposition of 1971 with the 155-cm reflector of the Catalina Station of the Lunar and Planetary Laboratory, University of Arizona (Sky and Telescope, 42, 1971, 134, 260, 263; 43, 1972, 20).

The grid conforms to the Mariner 9 areographic coordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, in press), and the individual features were approximately adjusted to that system by visual interpolation between the primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1122-JPL, October 1972, and Journal of Geophysical Research, in press).

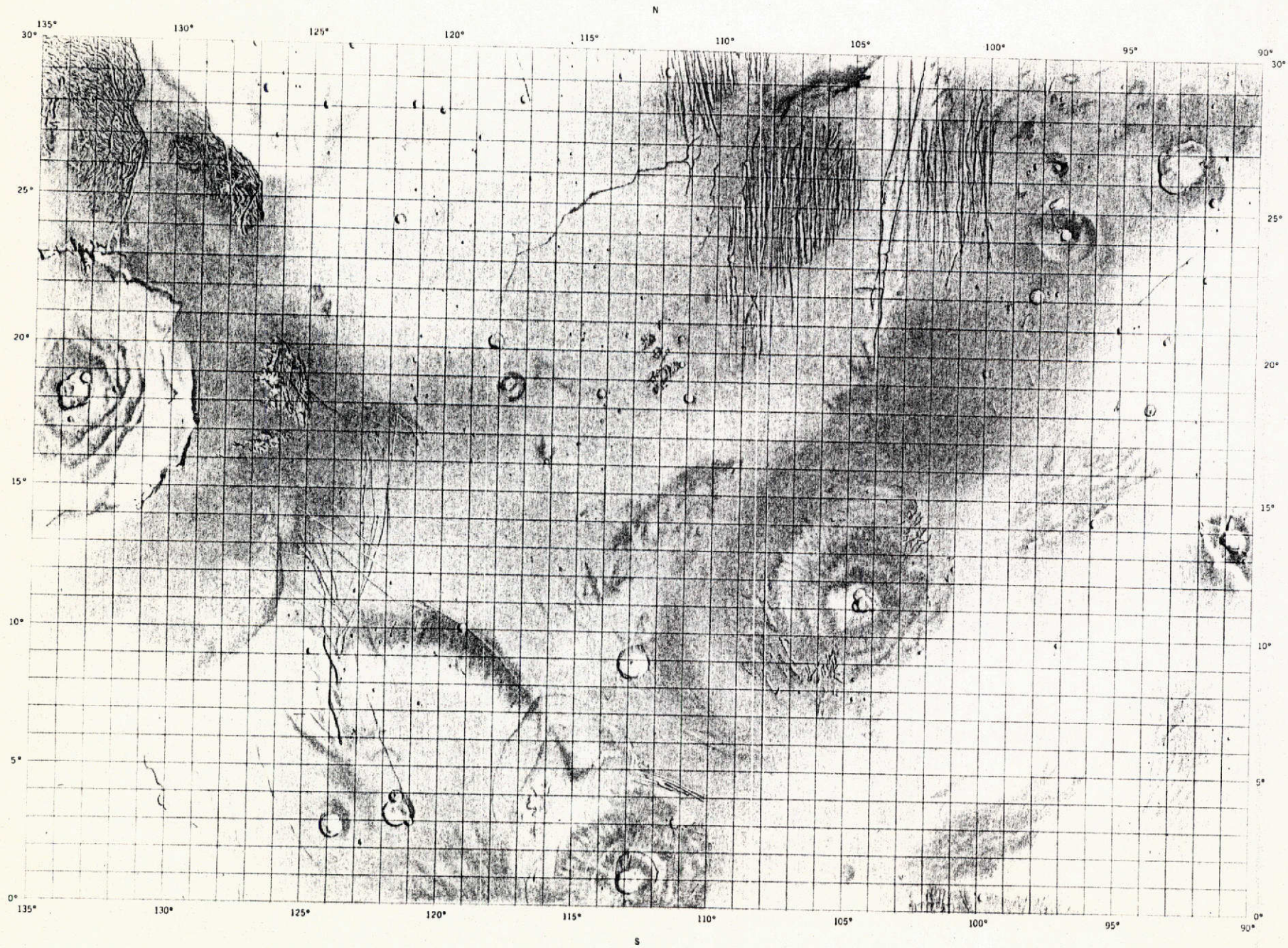
The relief is shown with reduced contrast to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the map, regardless of the actual illumination of the Mariner 9 pictures.

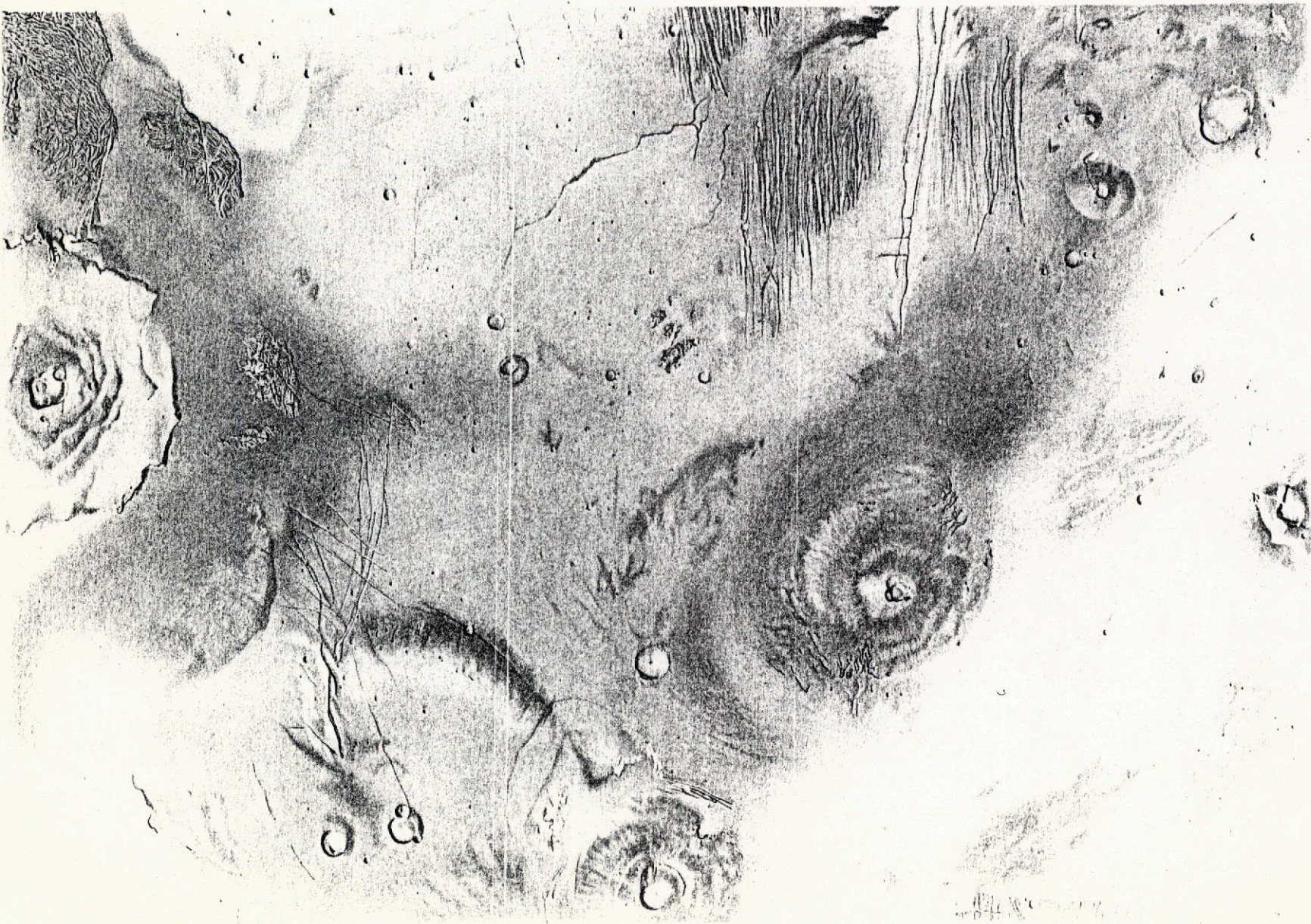
MERCATOR PROJECTION

Scale of the original art work is
1:5,000,000 at the equator

This chart was prepared by Ellen Bergman under the direction of Dr. G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

This document was produced for the Mariner Mars 1971 project under contract 952490 with the Jet Propulsion Laboratory, Pasadena, California.





MARINER 9 ALBEDO CHART OF MARS

CHART MC 10

LUNAE PALUS

15

Small-scale albedo markings from Mariner 9 rectified and unrectified photographs were combined with large-scale albedo markings from 1971 telescopic observations with the 155-cm reflector at the Catalina Station of the University of Arizona Lunar and Planetary Laboratory. Relief is shown to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the chart.

For want of quantitative photometric data from Mariner 9, a uniform gray scale of tonal values was established by means of the known relative visual brightness values of the bright and dark markings on Mars derived mainly from telescopic observations in 1941, 1958 and 1971. Since some contrast distortion in reproduction processes is unavoidable, a gray scale approximating the logarithmic brightness steps T and corresponding relative albedos β in white light is attached to the chart. For definition and calibration of the T scale, see G. de Vaucouleurs, Physics of the Planet Mars, Appendix II, 1954, and Icarus, November 1967, pp.310-349.

The grid conforms to the Mariner 9 areographic co-ordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, July 10, 1973). The individual features were adjusted to that system by visual interpolation between primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1309-JPL, June 1973) and by reference to a U. S. Geological Survey semicontrolled photomosaic dated February 1973.

MERCATOR PROJECTION

Scale of the original art work is
1:5,000,000 at the equator

The chart was prepared by Kay Walker under the direction of G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

The document was produced for the National Aeronautics and Space Administration under Grant NGR 44-012-279

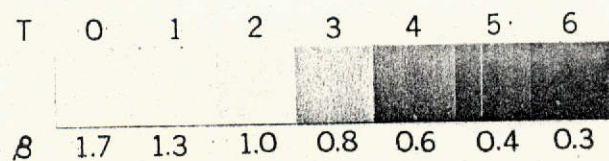
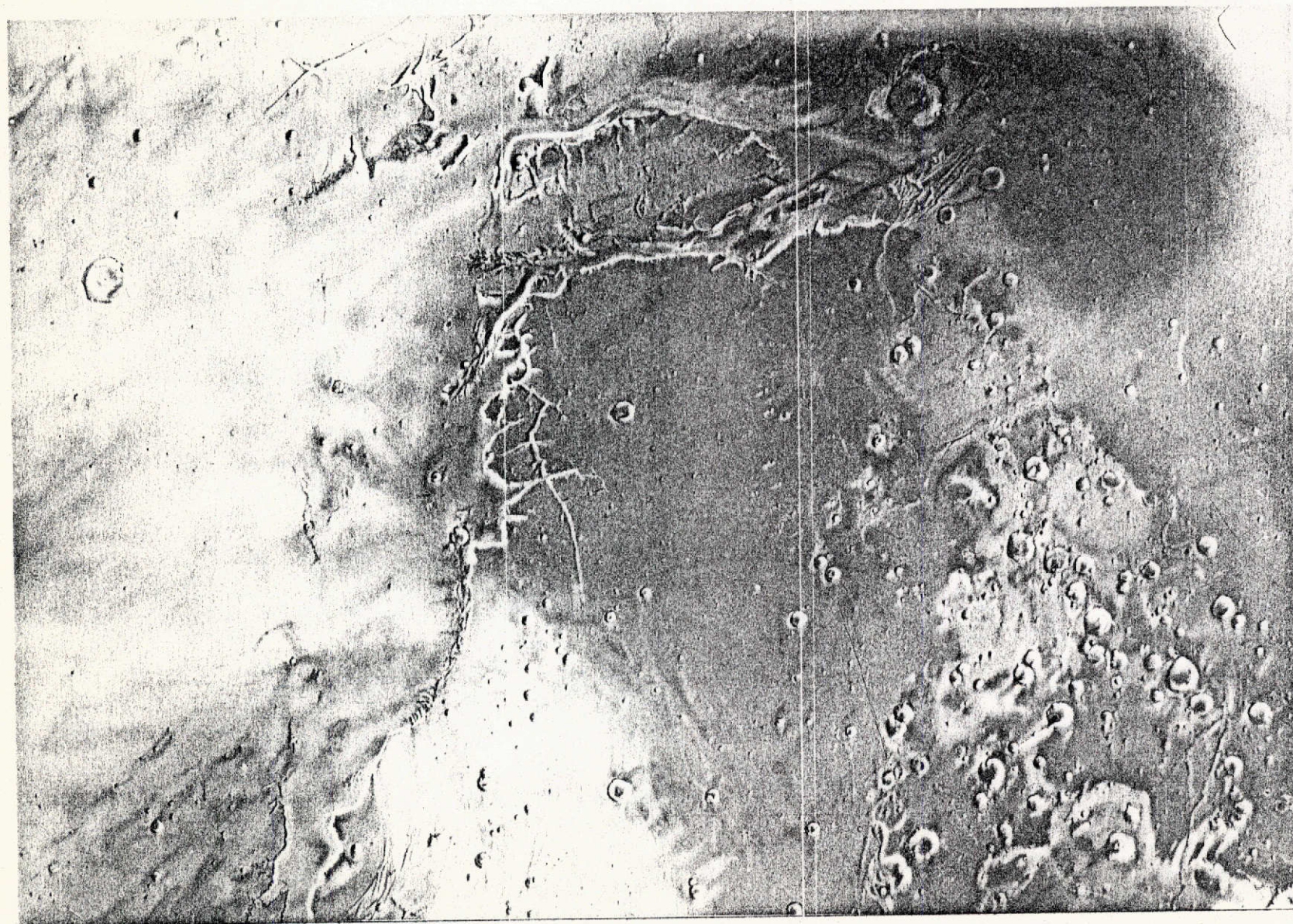


CHART MC 10
LUNAE PALUS

MARINER 9 ALBEDO CHART OF MARS

CHART MC 11

OXIA PALUS

17
A

Small-scale albedo markings from Mariner 9 rectified and unrectified photographs were combined with large-scale albedo markings from 1971 telescopic observations with the 155-cm reflector at the Catalina Station of the University of Arizona Lunar and Planetary Laboratory. Relief is shown to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the chart.

For want of quantitative photometric data from Mariner 9, a uniform gray scale of tonal values was established by means of the known relative visual brightness values of the bright and dark markings on Mars derived mainly from telescopic observations in 1941, 1958 and 1971. Since some contrast distortion in reproduction processes is unavoidable, a gray scale approximating the logarithmic brightness steps T and corresponding relative albedos β in white light is attached to the chart. For definition and calibration of the T scale, see G. de Vaucouleurs, Physics of the Planet Mars, Appendix II, 1954, and Icarus, November 1967, pp.310-349.

The grid conforms to the Mariner 9 areographic co-ordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, July 10, 1973). The individual features were adjusted to that system by visual interpolation between primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1309-JPL, June 1973) and by reference to a U. S. Geological Survey semicontrolled photomosaic dated February 1973.

MERCATOR PROJECTION

Scale of the original art work is
1:5,000,000 at the equator

The chart was prepared by James Roth under the direction of G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

The document was produced for the National Aeronautics and Space Administration under Grant NGR 44-012-279

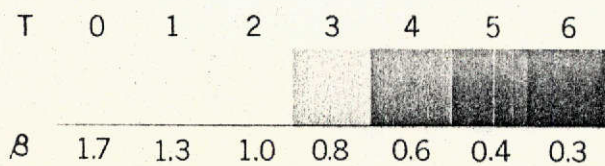
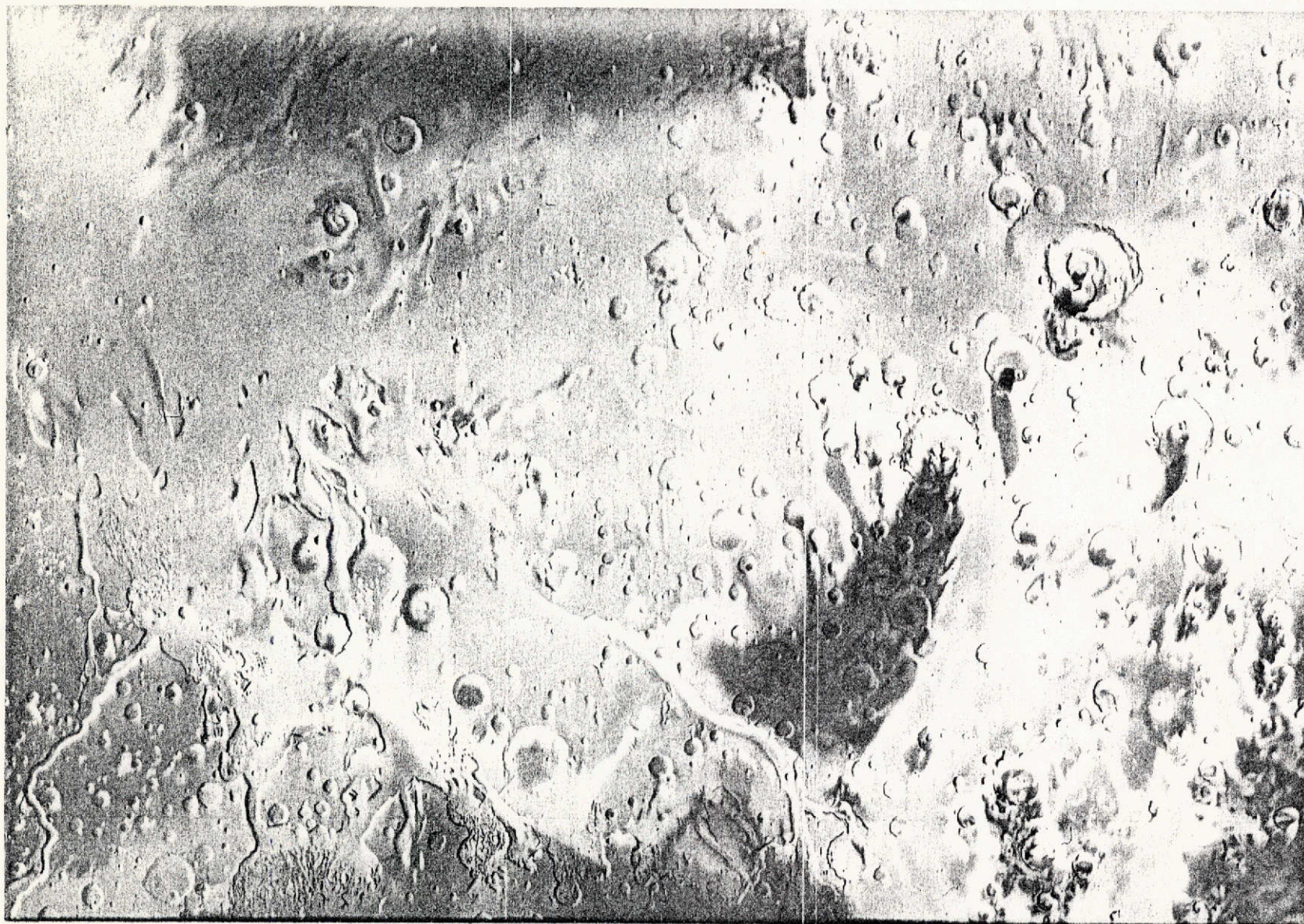


CHART MC 11
OXIA PALUS

MARINER 9 ALBEDO CHART OF MARS

CHART MC 15

ELYSIUM

19
A

Small-scale albedo markings from Mariner 9 rectified and unrectified photographs were combined with large-scale albedo markings from 1971 telescopic observations with the 155-cm reflector at the Catalina Station of the University of Arizona Lunar and Planetary Laboratory. Relief is shown to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the chart.

For want of quantitative photometric data from Mariner 9, a uniform gray scale of tonal values was established by means of the known relative visual brightness values of the bright and dark markings on Mars derived mainly from telescopic observations in 1941, 1958 and 1971. Since some contrast distortion in reproduction processes is unavoidable, a gray scale approximating the logarithmic brightness steps T and corresponding relative albedos β in white light is attached to the chart. For definition and calibration of the T scale, see G. de Vaucouleurs, Physics of the Planet Mars, Appendix II, 1954, and Icarus, November 1967, pp.310-349.

The grid conforms to the Mariner 9 areographic co-ordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, July 10, 1973). The individual features were adjusted to that system by visual interpolation between primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1309-JPL, June 1973) and by reference to a U. S. Geological Survey semicontrolled photomosaic dated February 1973.

MERCATOR PROJECTION

Scale of the original art work is
1:5,000,000 at the equator

The chart was prepared by Kay Walker under the direction of G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

The document was produced for the National Aeronautics and Space Administration under Grant NGR 44-012-279.

20<

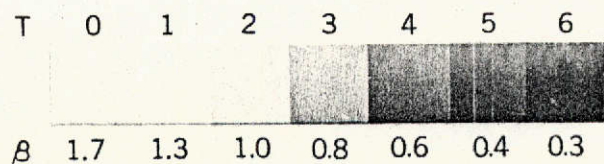
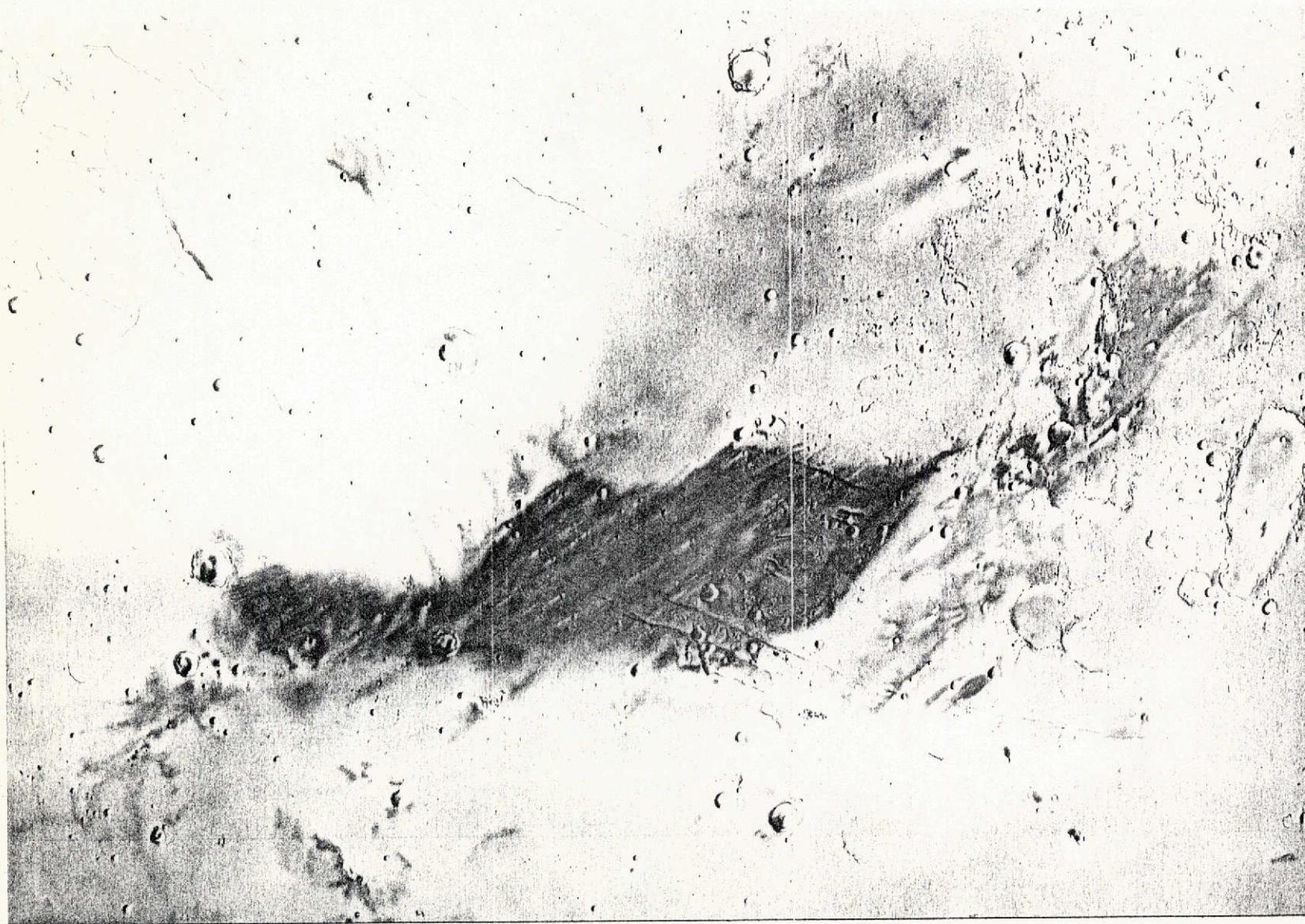


CHART MC 15
ELYSIUM

MARINER 9 ALBEDO MAP OF MARS

CHART MC 17

PHOENICIS LACUS

21
^

This map was made from both unrectified and rectified Mariner 9 photographs for small-scale features combined with ground-based telescopic observations for large-scale albedo markings. The latter were observed near the opposition of 1971 with the 155-cm reflector of the Catalina Station of the Lunar and Planetary Laboratory, University of Arizona (Sky and Telescope, 42, 1971, 134, 260, 263; 43, 1972, 20).

The grid conforms to the Mariner 9 areographic coordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, in press), and the individual features were approximately adjusted to that system by visual interpolation between the primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1122-JPL, October 1972, and Journal of Geophysical Research, in press).

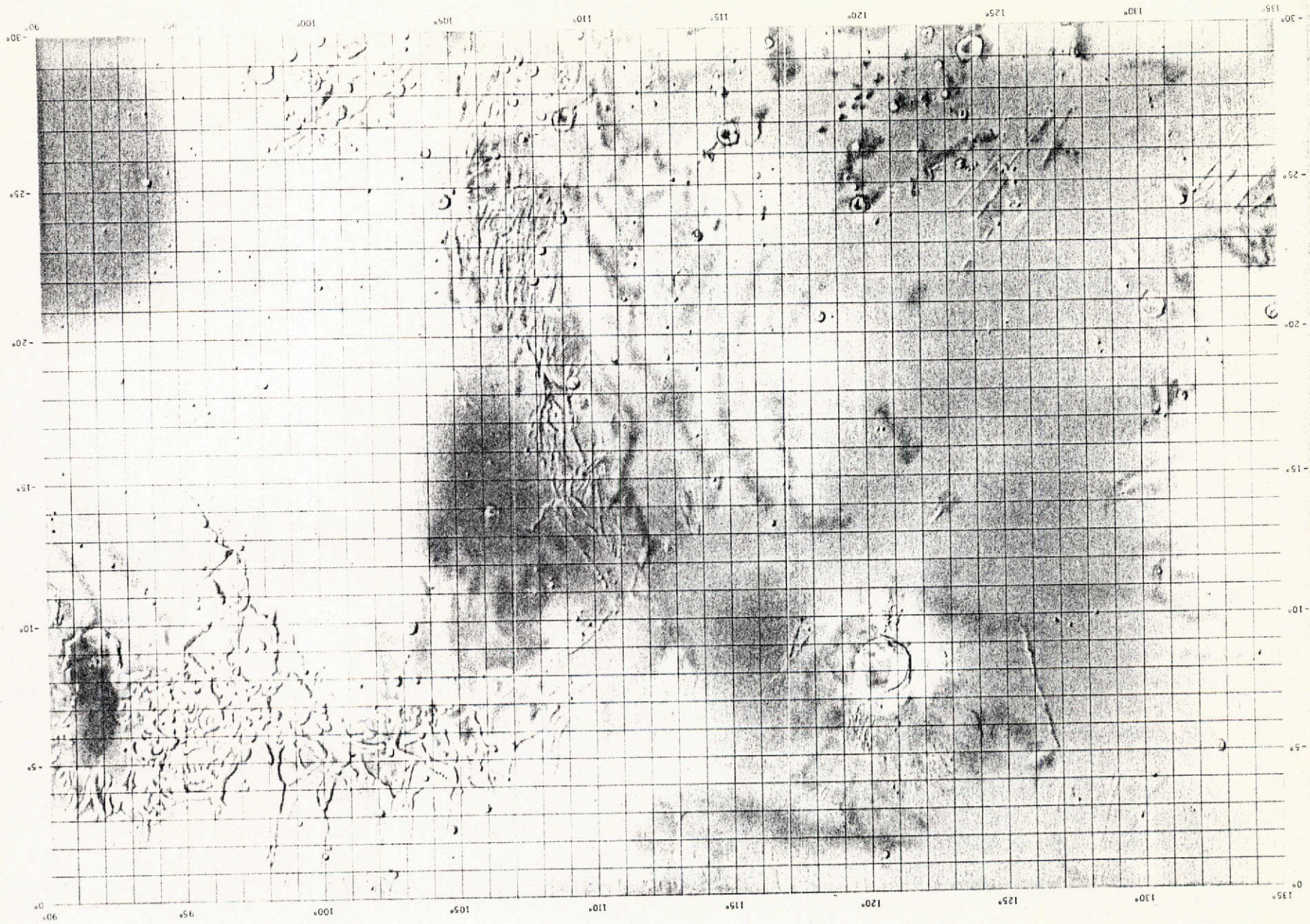
The relief is shown with reduced contrast to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the map, regardless of the actual illumination of the Mariner 9 pictures.

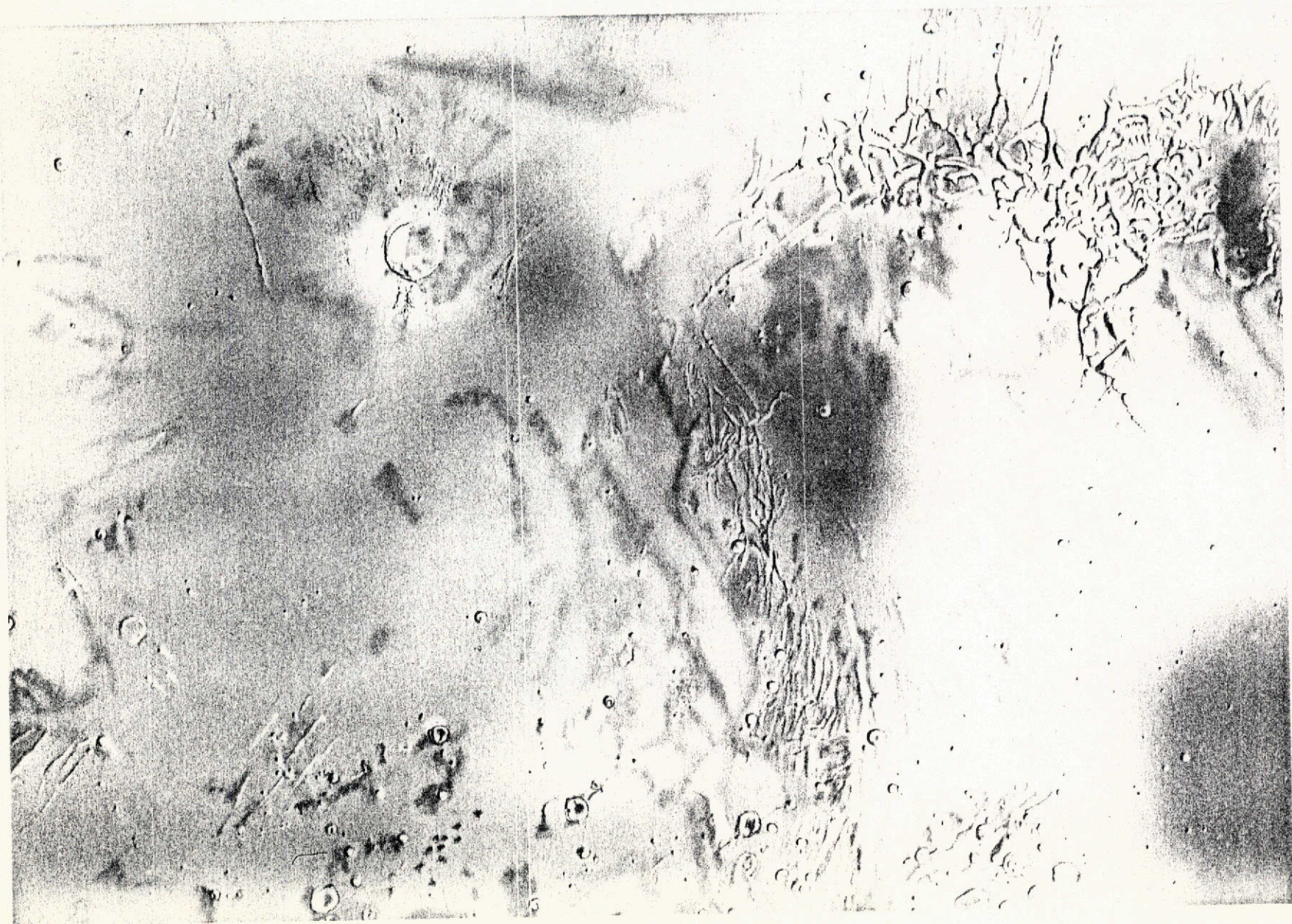
MERCATOR PROJECTION

Scale of the original art work is
1:5,000,000 at the equator

This chart was prepared by Kay Walker under the direction of Dr. G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

This document was produced for the Mariner Mars 1971 project under contract 952490 with the Jet Propulsion Laboratory, Pasadena, California.





MARINER 9 ALBEDO MAP OF MARS

CHART MC 18

COPRATES

24

This map was made from both unrectified and rectified Mariner 9 photographs for small-scale features combined with ground-based telescopic observations for large-scale albedo markings. The latter were observed near the opposition of 1971 with the 155-cm reflector of the Catalina Station of the Lunar and Planetary Laboratory, University of Arizona (Sky and Telescope, 42, 1971, 134, 260, 263; 43, 1972, 20).

The grid conforms to the Mariner 9 areographic coordinate system (G. de Vaucouleurs, M. E. Davies and F. M. Sturms, Journal of Geophysical Research, in press), and the individual features were approximately adjusted to that system by visual interpolation between the primary stations of the control net derived by M. E. Davies from Mariner 9 photographs (RAND Report R-1122-JPL, October 1972, and Journal of Geophysical Research, in press).

The relief is shown with reduced contrast to allow proper presentation and location of albedo patterns. A conventional westerly illumination is maintained throughout the map, regardless of the actual illumination of the Mariner 9 pictures.

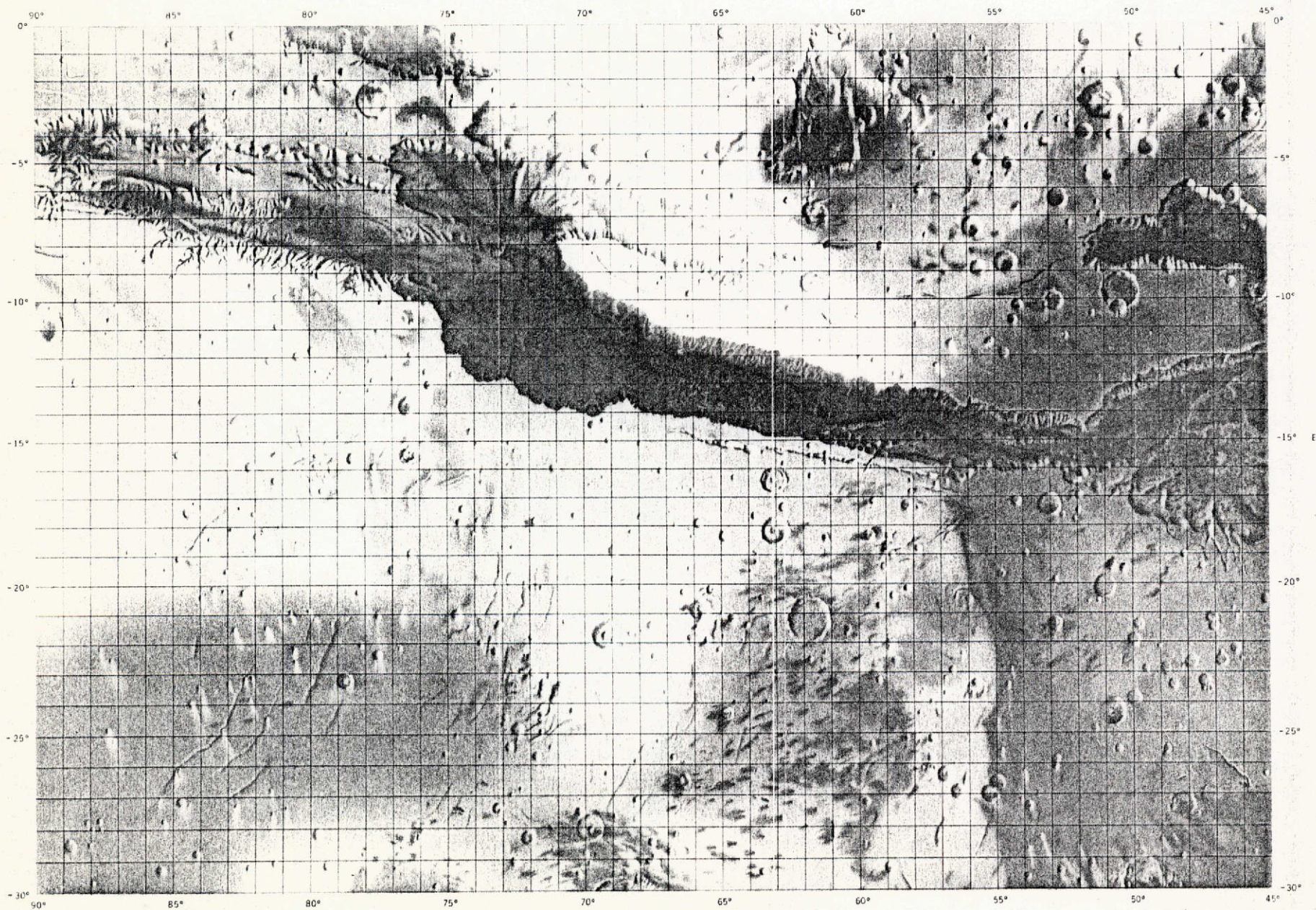
MERCATOR PROJECTION

Scale of the original art work is
1:5,000,000 at the equator

This chart was prepared by James Roth under the direction of Dr. G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

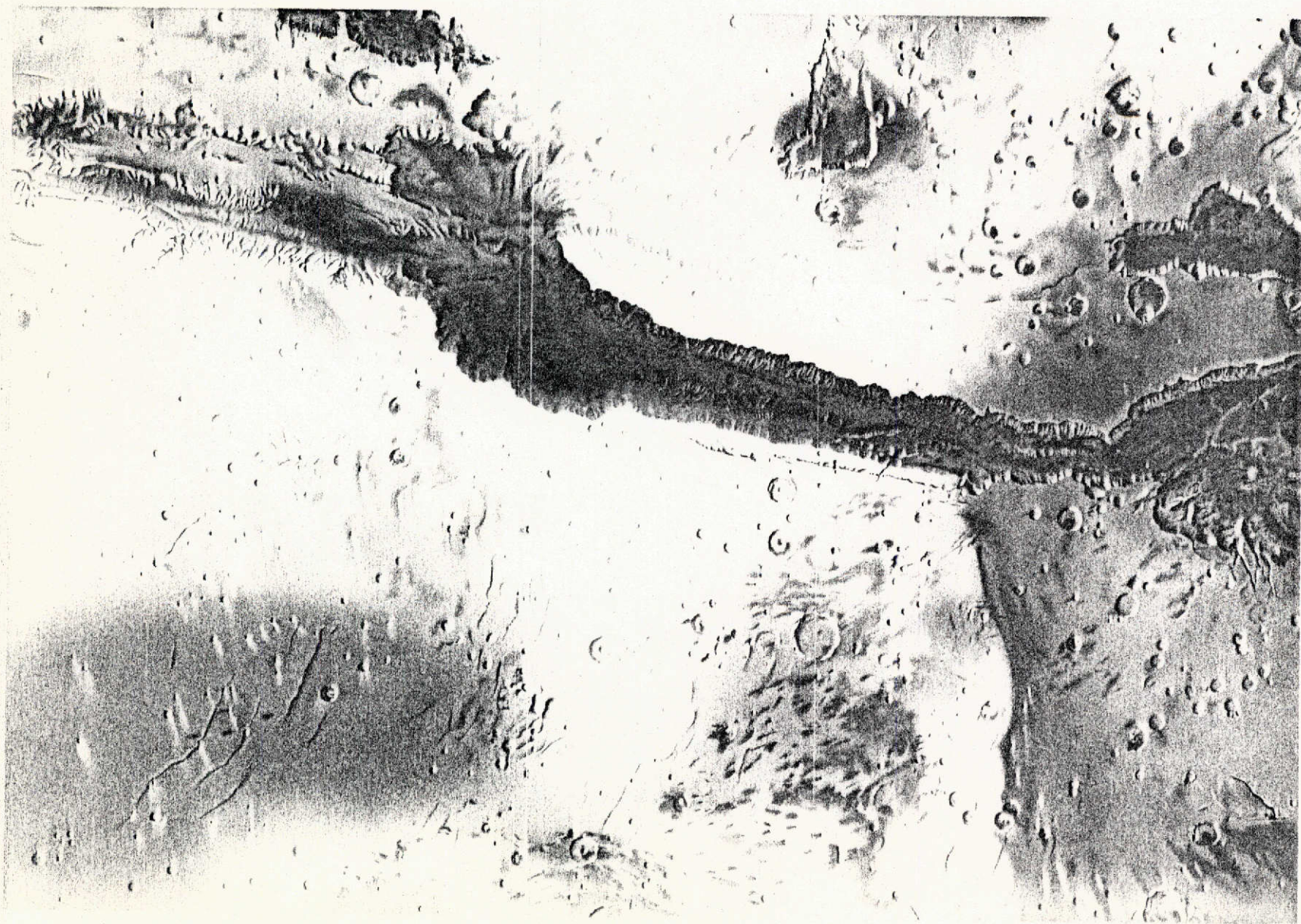
This document was produced for the Mariner Mars 1971 project under contract 952490 with the Jet Propulsion Laboratory, Pasadena, California.

N



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25



MARINER 9 ALBEDO MAP OF MARS

CHART MC-30 (PRELIMINARY)

MARE AUSTRALE

27
This preliminary albedo map of the South Polar region in stereographic projection was prepared mainly from rectified and unrectified Mariner 9 photographs filtered to show small-scale markings only. The grid does not conform precisely to the Mariner 9 coordinate system. However, use was made of the preliminary crater coordinates derived by M. Davies (Rand Report R-1122-JPL, Oct. 1972). Some adjustments were made to conform with a semi-controlled photomosaic prepared by U.S. Geological Survey.

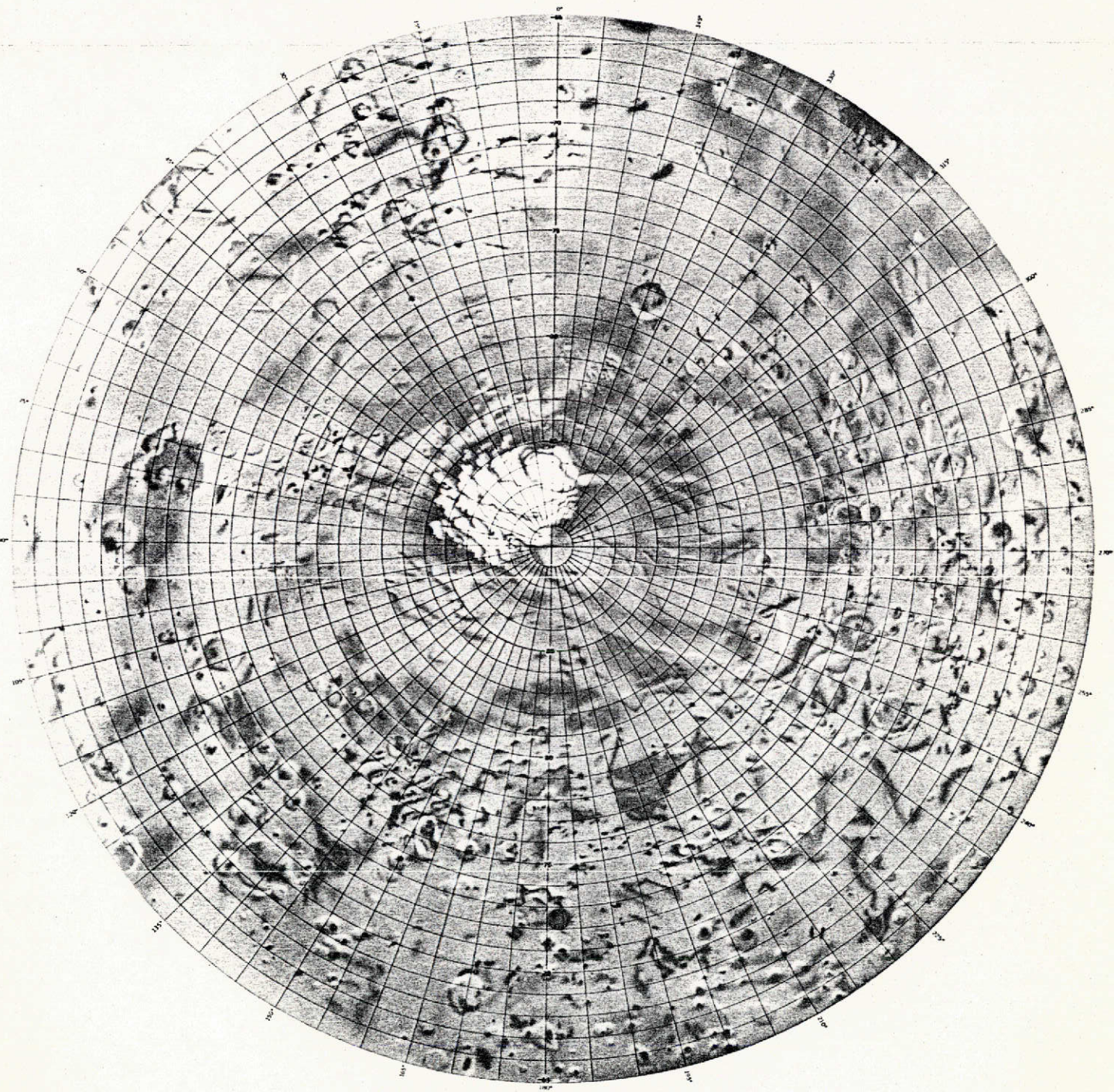
The relief is shown with reduced contrast to allow proper presentation and location of the local albedo patterns. Illumination from the north is maintained throughout the map, regardless of actual illumination of the Mariner pictures.

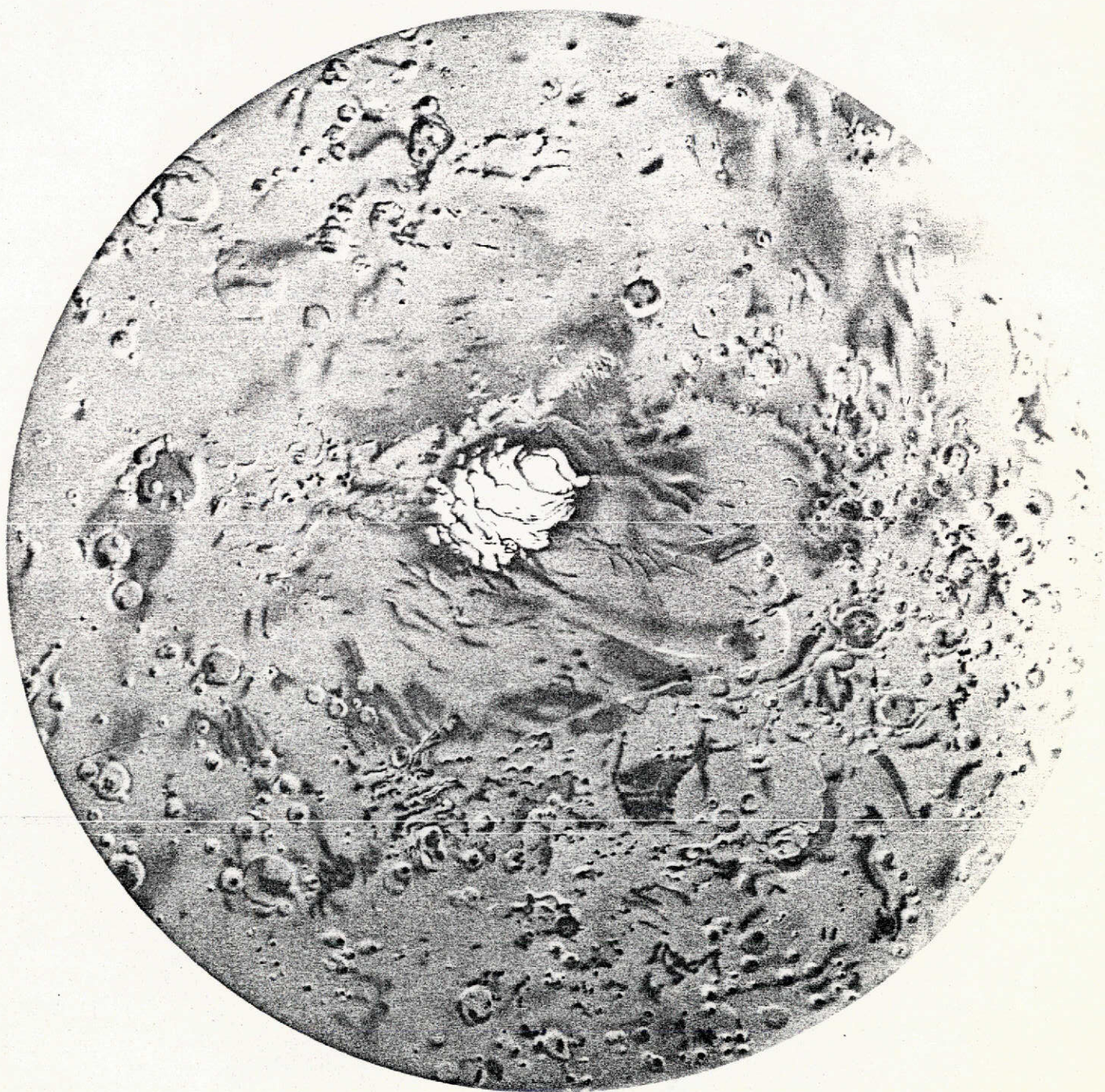
STEREOGRAPHIC PROJECTION

Scale of the original art work
is 1:5,000,000

This chart was prepared by James Roth under the direction of Dr. G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

This document was produced for the Mariner Mars 1971 project under contract 952490 with the Jet Propulsion Laboratory, Pasadena, California.





ALBEDO MAP OF MARS IN 1971

From Ground-Based Telescopic Observations

30
This map represents the large-scale albedo (bright and dark) patterns at the surface of Mars near its perihelic opposition in August 1971. It is based on visual and photographic observations with the 155-cm reflector of the Catalina Station of the Lunar and Planetary Laboratory, University of Arizona (Sky and Telescope, 42, 1971, 134, 260, 263; 43, 1972, 20).

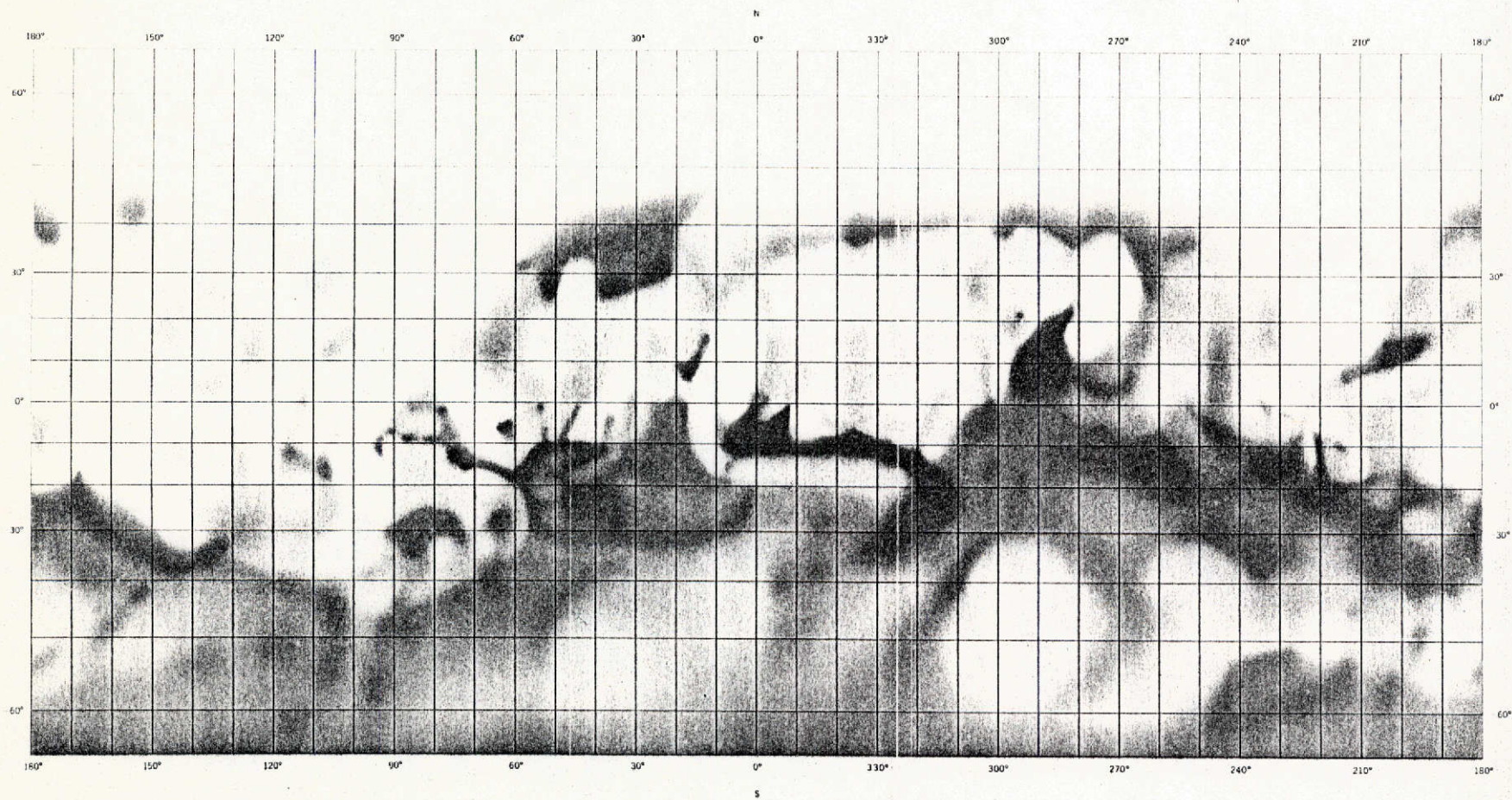
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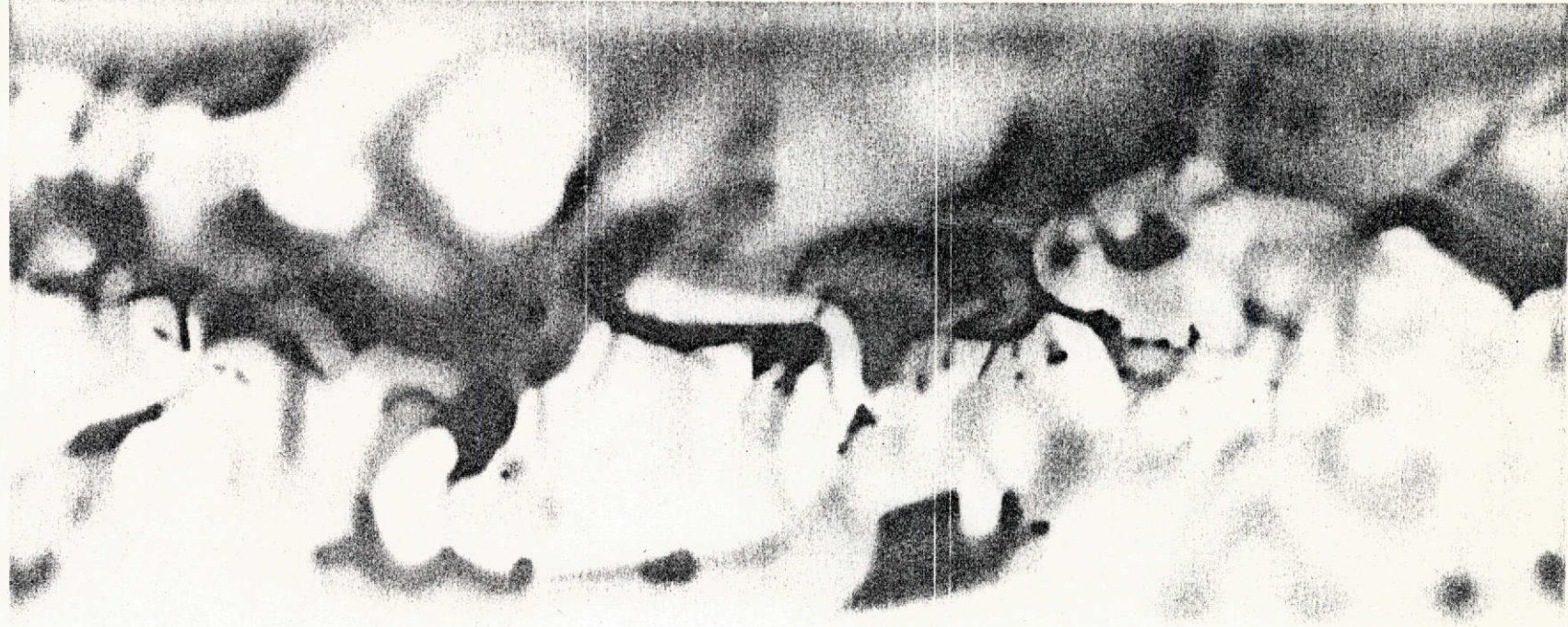
Scale of the original art work
is 1:25,000,000 at the equator

This chart was prepared by James Roth and Kay Walker under the direction of Dr. G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

This document was produced for the Mariner Mars project under contract 952490 with the Jet Propulsion Laboratory, Pasadena, California.

31





DETAIL OF SAMPLE STUDY USED IN PREPARATION OF MARS ALBEDO

CHARTS MC 12 (ARABIA) AND MC 13 (SYRTIS MAJOR)

To the extent of its completeness, this partial study of a segment of Mars is useful for a reliable preliminary look at valid Martian albedo patterns at one or more epochs. The study does not reflect changes that have occurred after the final Mariner 9 telemetry. The study is intended as an influence on the even more detailed albedo patterns to be presented in the University of Texas Mars Albedo Program 1:5,000,000 scale maps.

It is possible to correlate sufficiently well the many albedo features common to spacecraft and Earth-based photos. Careful examination and intercomparison of Mariner 9, 6, and 7 television pictures and the better Earth-based telescopic photographs suggests not only the unpredictable changes in some areas, but an equally unpredictable constancy in others.

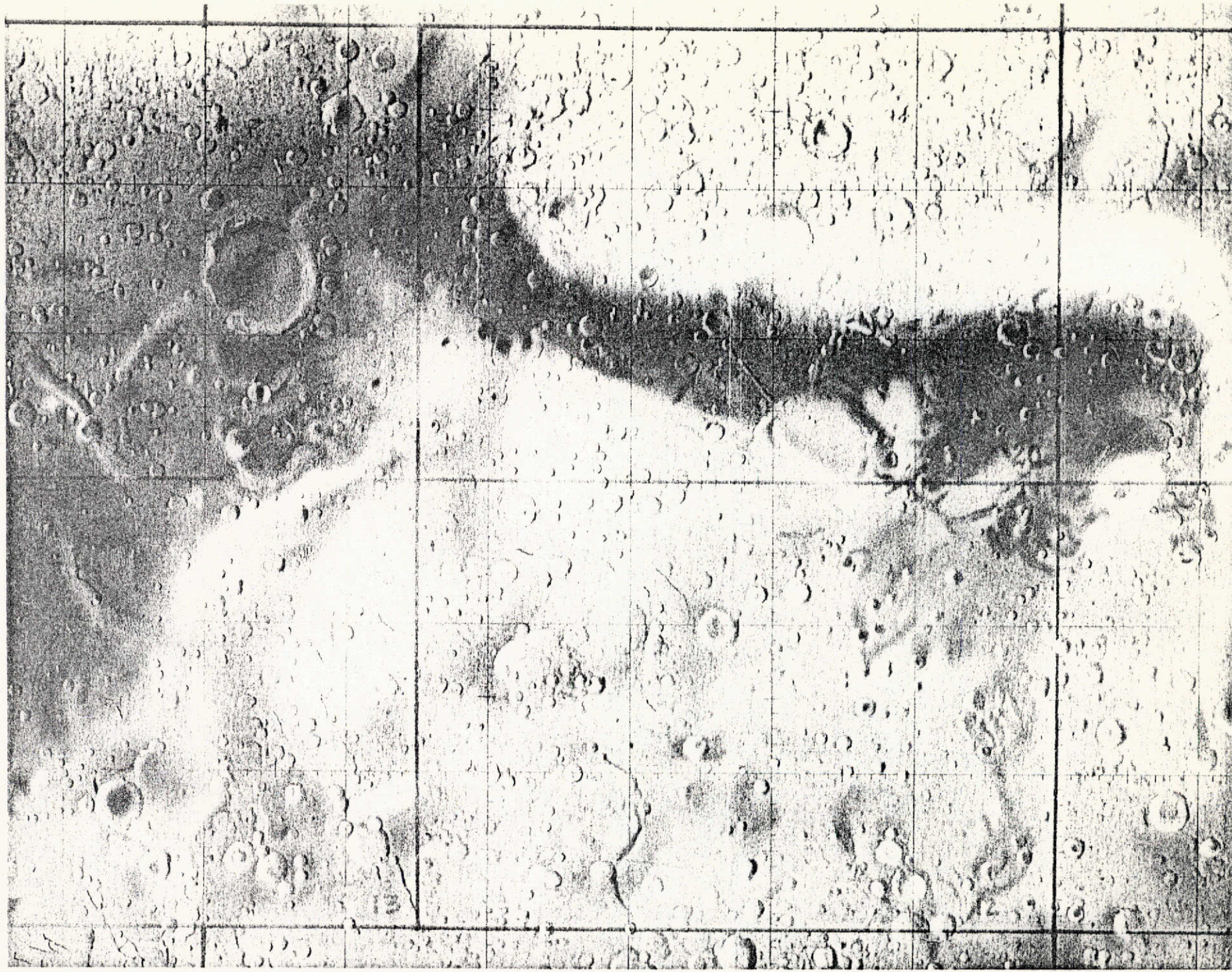
The original study uses the USGS 1:25,000,000 topographic Mars map as base, and, to the extent of completeness, is believed to represent a higher - order combination of Mars albedo and topography than previous efforts at that scale.

MERCATOR PROJECTION

Scale of the original art work is
1:25,000,000 at the equator

The study was prepared by James Roth under the direction of G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

The study is primarily intended for internal use at Texas in the Mariner 9 Albedo mapping program supported by the National Aeronautics and Space Administration under Grant NGR 44-012-279



SAMPLE OF STUDY USED IN PREPARATION OF MARS ALBEDO

CHARTS MC 12 (ARABIA) AND MC 13 (SYRTIS MAJOR)

To the extent of its completeness, this partial study of a segment of Mars is useful for a reliable preliminary look at valid Martian albedo patterns at one or more epochs. The study does not reflect changes that have occurred after the final Mariner 9 telemetry. The study is intended as an influence on the even more detailed albedo patterns to be presented in the University of Texas Mars Albedo Program 1:5,000,000 scale maps.

It is possible to correlate sufficiently well the many albedo features common to spacecraft and Earth-based photos. Careful examination and intercomparison of Mariner 9, 6, and 7 television pictures and the better Earth-based telescopic photographs suggests not only the unpredictable changes in some areas, but an equally unpredictable constancy in others.

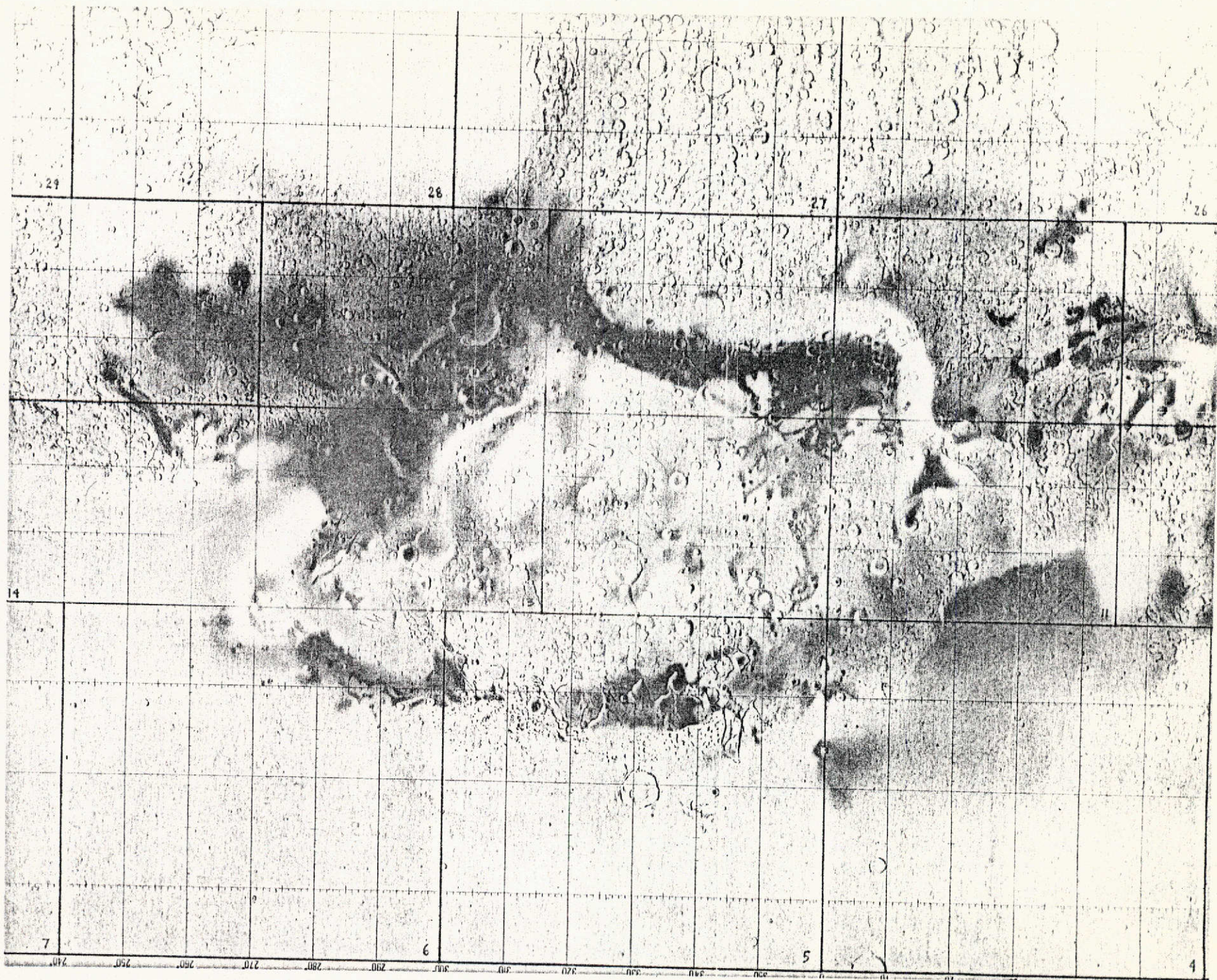
The original study uses the USGS 1:25,000,000 topographic Mars map as base, and, to the extent of completeness, is believed to represent a higher - order combination of Mars albedo and topography than previous efforts at that scale.

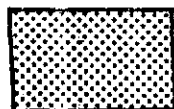
MERCATOR PROJECTION

Scale of the original art work is
1:25,000,000 at the equator

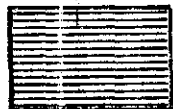
The study was prepared by James Roth under the direction of G. de Vaucouleurs, Department of Astronomy, The University of Texas at Austin.

The study is primarily intended for internal use at Texas in the Mariner 9 Albedo mapping program supported by the National Aeronautics and Space Administration under Grant NGR 44-012-279

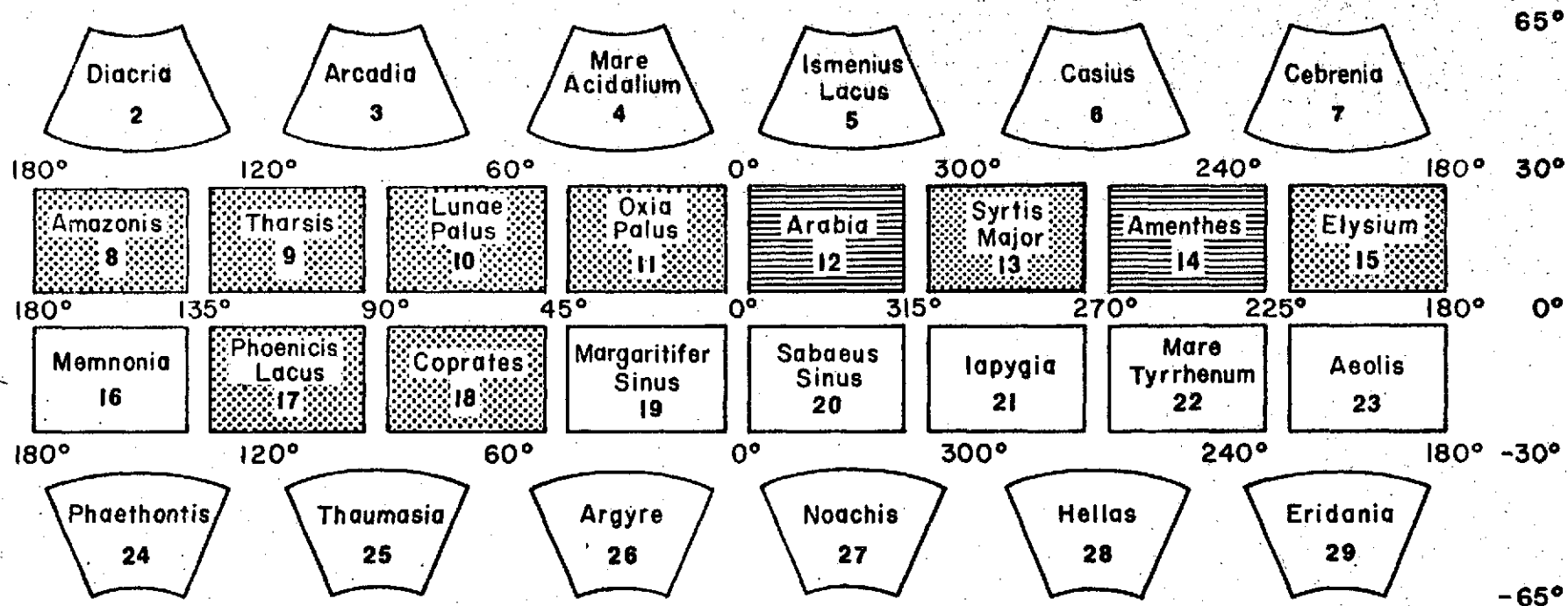
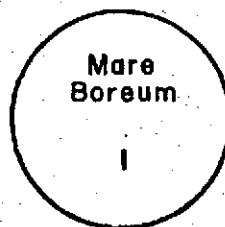


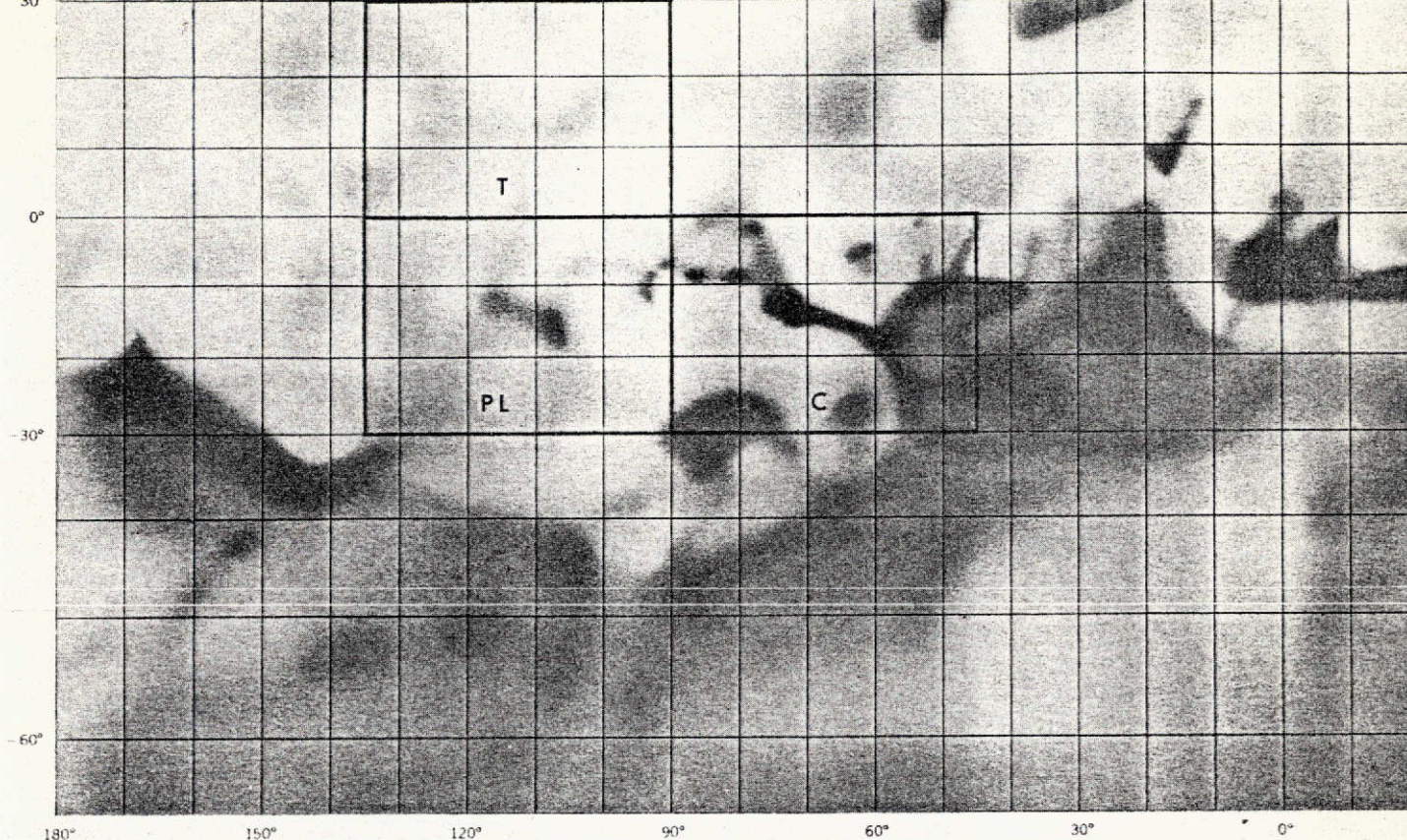


Mars Chart quadrangles
completed by University
of Texas to date



In progress (6-30-74)





Part of a 1971 chart of Mars, prepared by James Roth and Kay Walker from observations by G. de Vaucouleurs with the 61-inch reflector of the Lunar and Planetary Laboratory. The scale of this reproduction is 1:66,000,000 and north is up. To match the orientation of the other maps with this article, turn this one 90° counterclockwise. Names of the larger Martian features appeared on a key chart on page 287 of the May, 1971, issue. The outlined areas are those shown in the three large-scale albedo charts: C, Coprates; PL, Phoenixis Lacus; and T, Tharsis. All illustrations were produced at the University of Texas for the Mariner Mars project, under contract with Jet Propulsion Laboratory.

High-Resolution Mars Albedo Maps

GERARD DE VAUCOULEURS, *University of Texas at Austin*

AS A MAPPING MISSION, the Mariner 9 flight to Mars in 1971-72 greatly extended the preliminary reconnaissance by Mariner 4 in 1965 and Mariners 6 and 7 in 1969. The television experiment aboard Mariner 9 was planned to produce the first complete map of the Martian surface at a resolution far greater than that of telescopic observations. The two Vidicon cameras provided ground resolution of about 1.0 and 0.1 kilometer from 1,200 kilometers, the average minimum altitude in the spacecraft's orbit around Mars.

Altogether, over 8,000 TV pictures were received from Mariner 9. Headed by the author, the Geodesy/Cartography Group of the TV experiment team prepared a coordinated plan for the best use of this material in the systematic mapping of Martian surface features. Our work was divided into four broad categories:

1. Definition of an improved areographic coordinate system.
2. Derivation of standard areographic coordinates for a planet-wide net of control stations.
3. Preparation of photomosaics and topo-

graphic charts of surface relief on the planet.

4. Preparation of albedo charts of the surface.

We also actively considered, in close liaison with the International Astronomical Union working group on Martian nomenclature, the problems of naming the surface features newly discovered by Mariner 9.

It was decided to prepare two basic atlases of Mars, one topographic, the other photometric, covering the whole planet on a scale of 1:5,000,000, where one millimeter represents five kilometers. (A topographic Mars chart at 1:25,000,000 was also made, and was reproduced in *SKY AND TELESCOPE* for August, 1972.)

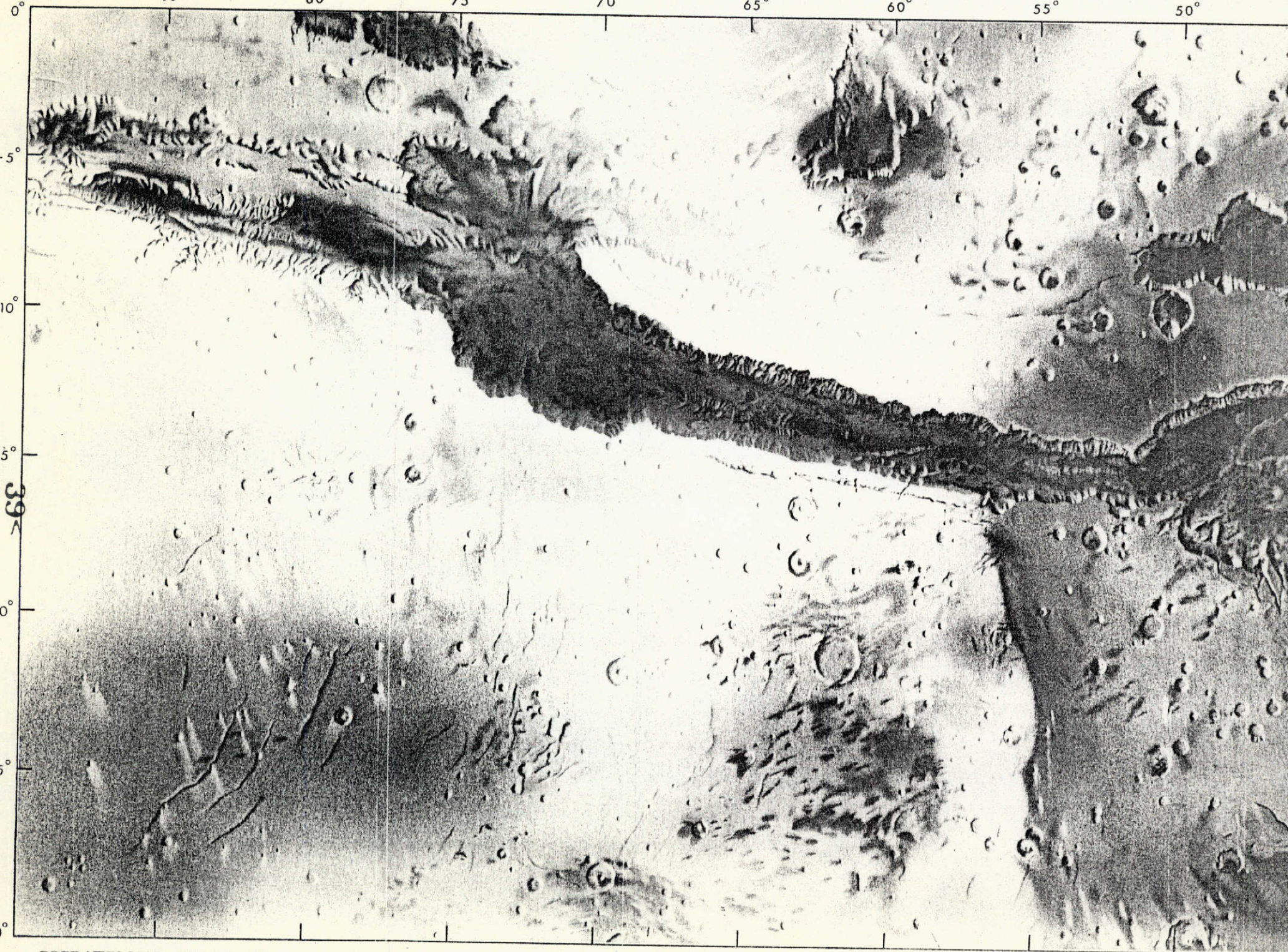
Opposite and on the two following pages are the first three of the 30 sheets from the albedo atlas, reduced in scale. The areas that they cover are identified on the albedo map above, which was prepared from ground-based observations.

Each Mars chart (MC) is called by a serial number and by the name of some prominent feature within its boundaries. Thus, the examples here are MC9 Tharsis; MC17 Phoenixis Lacus; and MC18

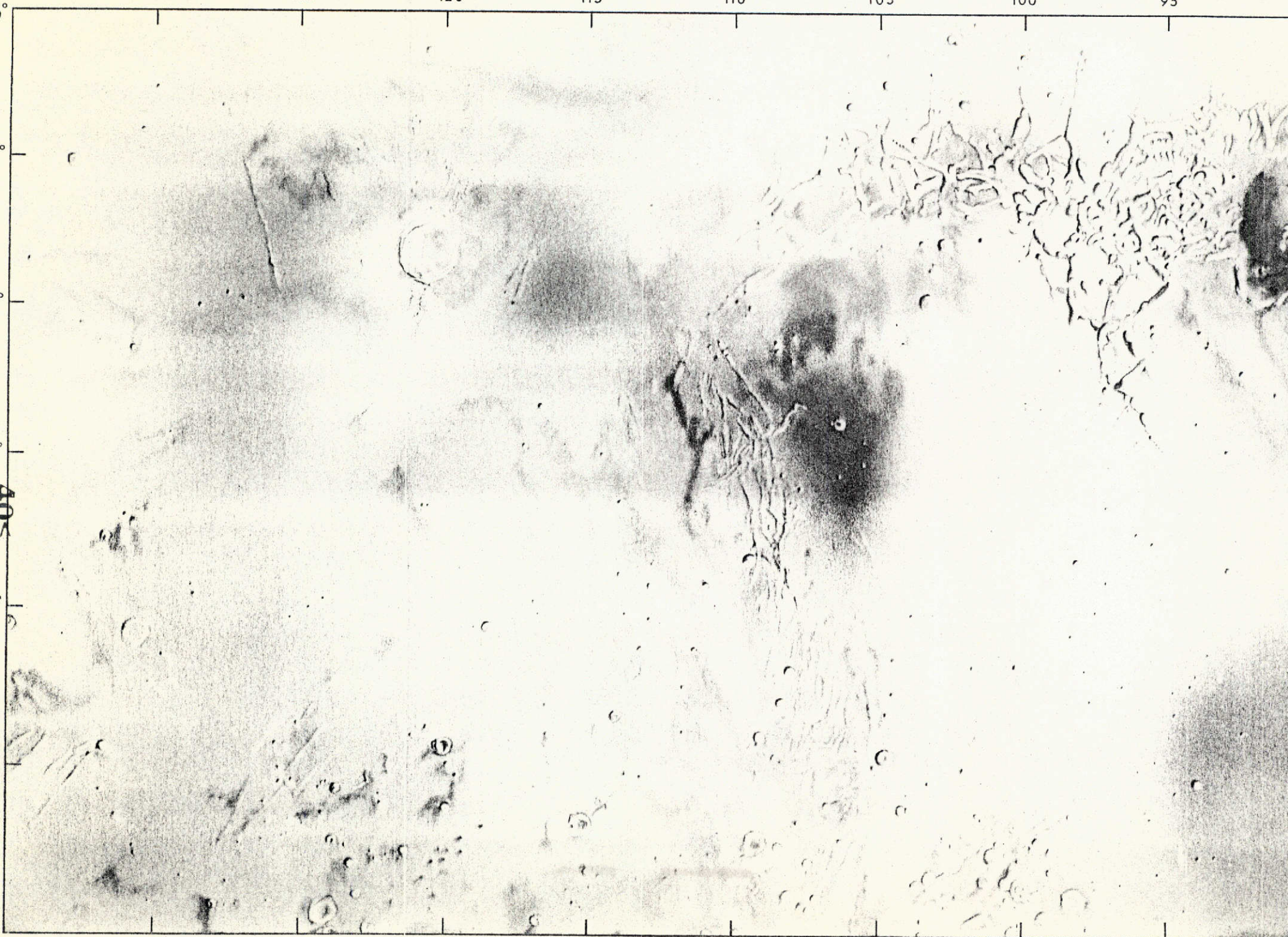
Coprates. The charts will be published in a 26-by-27-inch format in two versions, with and without a coordinate grid.

Because of cost, time, and technical limitations, the Mariner 9 TV data have not yet been analyzed from a photometric point of view. This may not be done for a long time, at least on a planet-wide basis. Also, the digital data were filtered to enhance small-scale topographic relief, a process which effectively wiped out the large-scale albedo features. Therefore, to establish a uniform albedo scale for large and small features that would be consistent from map to map, we had to make constant reference to ground-based photometric data obtained during 1971 prior to the dust storm and during the favorable oppositions of 1941 and 1958.

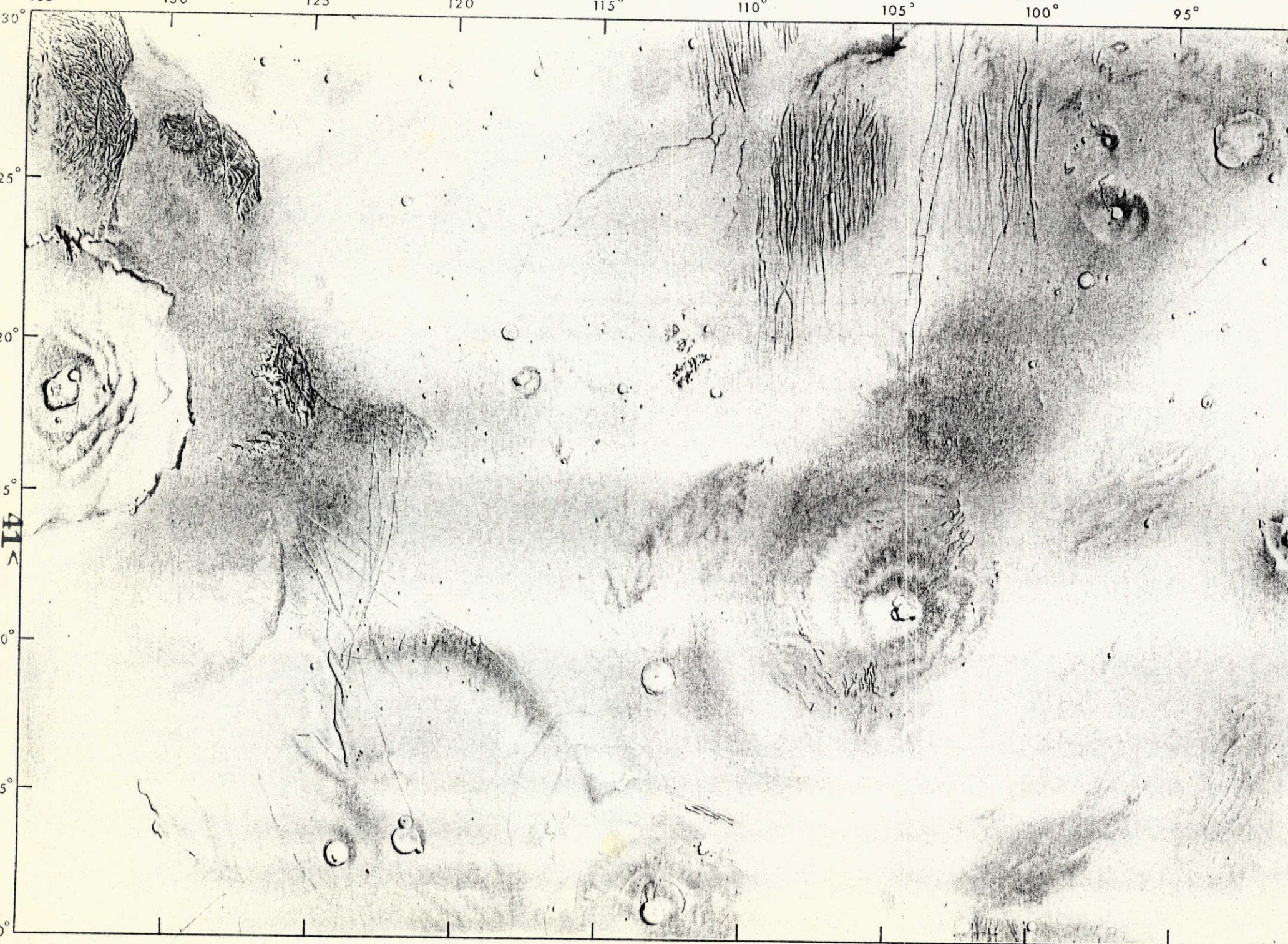
I was ably aided in this task by James Roth, who has long experience in Martian cartography, and by several other assistants. Maps 17 and 18 were done with an airbrush while Map 9 was drawn with a lead pencil; the latter technique takes more time but allows better control of fine detail. Only five of the 30 albedo charts could be completed before the end of the Mariner 9 program, for which the Jet Propulsion Laboratory was the prime contractor. It is hoped that this atlas will be completed in the next two or three years with NASA support.



COPRATES MAP. This 1.7-million-square-mile area is dominated by the Coprates canyon. Aurorae Sinus fills the right edge; the black spot at longitude 62°, latitude -4°, is Juventae Fons. At lower left, many craterlets in Solis Lacus have windblown dust tails. Reproduction scale is 1:9,600,000. Drawn by J. Roth.



PHOENICIS LACUS MAP. One of Mars' great volcanoes, Fulgens Mons (near 121°, -8°) is famous for the spectacular recurrent clouds that form above and around it at certain Martian seasons. The relief on these large-scale maps is rendered with reduced contrast to allow proper representation of the albedo patterns. Drawn by Kay Walker.



THARSIS MAP. At the left edge is the giant volcanic cone Nix Olympica. Note also the wrinkled lava fields and surface cracks. These large-scale maps were prepared from Mariner 9 photographs. Coordinates are based on a preliminary net of control points calculated by M. Davies, Rand Corp. Drawn by Ellen Bergman.